The Lactation Biology Symposium entitled “The long-term impact of epigenetics and maternal influence on the neonate through milk-borne factors and nutrient status” was held at the Joint Annual Meeting of the American Society of Animal Science, American Dairy Science Association, Canadian Society of Animal Science, Asociación Mexicana de Producción, and the Western Section of the American Society of Animal Science in Phoenix, AZ, July 15 to 19, 2012. The goals of the symposium were to explore potential means by which colostrum and milk may affect growth and development of offspring immediately after birth (Hammon et al., 2013; Hinde et al., 2012, 2013), into adulthood (Soberon and Van Amburgh, 2013), and in subsequent generations (Paten et al., 2013). The symposium was exceptional in that it brought together scientists that work in the broad area of lactation biology but use different animal models to verify hypotheses; the mixed platform of speakers and their corresponding expertise offered a unique opportunity for exchange of ideas and information.

The importance of colostral immunoglobulins for passive transfer of immunity has long been recognized and this was, therefore, not the focus of the symposium. Rather, biologically active colostral and milk factors, both identified and still unknown, were the focal point. The first speaker, H. M. Hammon (Leibniz Institute for Farm Animal Biology, Dummerstorf, Germany) reported on the influence of colostrum and its associated growth factors and hormones on glucose metabolism in neonatal calves (Hammon et al., 2013). He shared data showing that glucose homeostasis in young calves can be positively impacted by feeding of colostrum. At the intestinal level, colostrum intake promotes cell growth and protein synthesis. Additionally, colostrum enhances lactose digestion and glucose absorption in the neonate. It was also noted that improved glucose status in colostrum-fed calves is likely a prerequisite for maturation of the somatotropic axis. The last point made by Hammon et al. (2013) was that whereas local effects of colostrum are characterized, systemic effects of bioactive factors in colostrum are not described at present, and further work in this area is required.

The second speaker, P. R. Kenyon (Massey University, Palmerston North, New Zealand), reported on an ongoing trial in sheep studying the effects of maternal nutrition level during pregnancy on lactational characteristics of progeny (Paten et al., 2013). Earlier studies with varying dam feeding regimens during pregnancy (van der Linden et al., 2009; Blair et al., 2010) showed that the mammary gland is sensitive to maternal nutrition during pregnancy. The reported study aimed at identifying critical feeding periods during pregnancy and to clarify previous findings. In early pregnancy...
(d 21 to 50), both sub- or overmaintenance feeding of the dam had a tendency to reduce milk yield in first generation offspring compared with maintenance feeding. In contrast, dam nutrition in the latter part of pregnancy (d 40 to 140) had little effect on offspring milk production. Granddam nutrition regimen did not affect second generation offspring birth weights, but weaning weights of second generation offspring from dams with overmaintenance feeding during early pregnancy were less. Although many of the reported milk yield and growth effects were small, they could be important enough to have economic impacts and, therefore, studies into the mechanisms responsible for nutritional programming of the mammary gland itself or of metabolism and nutrient partitioning are warranted.

In the third presentation, K. Hinde (Human Evolutionary Biology, Harvard University, Cambridge, MA) discussed how infant behavior and somatic development can be altered through lactational programming (Hinde et al., 2012). Presenting research from rhesus monkeys, a close human relative evolutionarily speaking, Hinde revealed that nutritional components in milk not only contribute to infant somatic growth (Hinde et al., 2009) but that mother’s milk seemingly programs infant behavioral development. Infants whose mothers produce more milk energy and greater concentrations of milk cortisol are characterized as more “confident,” which was described as being more active, playful, exploratory, and bold (Hinde and Capitanio, 2010; Sullivan et al., 2011). Milk is, therefore, not merely food that allows the body to grow but it contains constituents that help build the brain and provide the energy that allows infants to be behaviorally active, thereby gaining experiences that shape the mind (Hinde, 2013).

The fourth talk was given by F. F. Bartol (Auburn University, Auburn, AL). In his presentation, he reviewed the concept of “lactocrine” signaling, a term that his group first described in 2008 (Bartol et al., 2008). Lactocrine signaling is defined as the transmission of bioactive factors from mother to offspring as a consequence of nursing. The long-term impacts of such programming on the development of the offspring were reported, with particular reference to the pig. Indeed, there is evidence in swine of lactocrine-mediated effects on development of the female reproductive tract (Chen et al., 2011) and cervical protein expression (Frankshun et al., 2012). The authors emphasized the great diversity of potential lactocrine signals present in colostrum and milk, which, most likely, act collectively or cooperatively instead of independently (Bartol et al., 2013). Lastly, they stated that the conditions necessary to support maternal lactocrine signaling processes are yet to be determined.

The final talk was given by F. Soberon (Cornell University, Ithaca, NY). He presented results from a meta-analysis designed to better describe the association between dairy calf nutrition in early life and first lactation milk yield (Soberon and Van Amburgh, 2013). The meta-analysis included results from 11 studies conducted over the last 20 yr. It was estimated that calves fed milk or milk replacer with growth rates of 0.60 to 0.80 kg/d before weaning produced 429 ± 106 kg more milk during first lactation compared with calves fed to gain 0.25 to 0.40 kg BW/d before weaning (Soberon and Van Amburgh, 2013). These data demonstrate the positive effect of nutrient intake from milk or milk replacer during the preweaning period (first 2 mo of postnatal life for dairy calves) on later milk production initiated at approximately 2 yr of age.

Accumulating research evidence from a variety of mammalian species (i.e., sheep, pigs, dairy cattle, and rhesus monkeys) points to both the nutritive and non-nutritive (e.g., hormones, growth factors) value of milk. Lactocrine signaling is now being acknowledged as an integral part of developmental programming and enhances the capacity of neonates to sense, respond, and adapt to the circumstances into which they are born. In controlled studies, observed phenotypic responses to colostrum or milk include improved glucose homeostasis, differential behavioral and reproductive development, and altered somatic growth and milk yield. Furthermore, developmental disruption by aberrant exposure to bioactive compounds can change tissue developmental trajectories, and the neonatal period is a phase during which cells and tissues are most sensitive to such misprogramming (Bartol et al., 2013). In summary, more research is needed in this area to further identify and catalog bioactive factors in milk and to define the molecular mechanisms through which they operate. Comparative reviews of findings from multiple species, such as offered in this symposium, will further advance our knowledge and likely speed the pace at which new discoveries are made.

**LITERATURE CITED**


