

## Initiation of Lactation

### Professor Peter Hartmann, PhD

University of Western Australia, Perth (Australia)

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The scientific exploration of the origin of lactation has developed along two different lines of thinking. One line of investigation has been a consideration of the evolutionary origin of lactation and the other line has been a development, over time, of a biological understanding of the actual processes involved in milk production. The evolutionary origin of the mammary gland has been difficult to establish because little knowledge can be gained on the origin of soft tissue organs from the fossil records. Three recent innovative approaches have been taken to explain the ancestral development of the mammary gland and lactation. One approach identified skin glands that could have been the ancestral mammary glands from a comparative analysis of the anatomy of existing 'primitive' mammals and the incubation and hatching of soft-shelled eggs in these animals. Another approach examined the metabolic and molecular synergy between the highly conserved innate immune system and both milk composition and the regulation of the synthesis and secretion of milk. A third approach has been to review comparative genomic and transcriptomic evidence for the development of lactation. All approaches conclude that the development of a fully functional lactating mammary gland predates the origin of mammals and that the primitive beginning for the mammary gland probably date back more than 310 million years. Historical concepts on the biology of lactation have been recorded since the time of Ancient Greeks. They believed that milk was derived from special vessels that connected the uterus to the breasts. Alternatively, the "chyle theory" on the origin of milk held that milk was derived from the digestive tract and this theory persisted well into the nineteenth century when it was correctly concluded that milk components were derived from blood and that some milk constituents were actually synthesized within the mammary glands. The demonstration that milk secretion was a continuous process and that milk ejection was the expulsion of milk that had already been secreted, set the background for the development for the current understanding of milk synthesis, secretion and removal. Today we know that there are two stages to the initiation of lactation, secretory differentiation (previously termed - lactogenesis I) and secretory activation (previously termed lactogenesis II). Secretory differentiation represents the stage of pregnancy when the mammary epithelial cells differentiate into lactocytes (mammary secretory epithelial cells) with the capacity to synthesize unique milk constituents such as lactose and alpha lactalbumin. This process requires the presence of a 'lactogenic hormone complex' of the reproductive hormones, estrogen, progesterone, prolactin and some metabolic hormones. Secretory activation on the other hand, is the initiation of copious milk secretion and is associated with major changes in the concentrations of many milk constituents. The withdrawal of progesterone triggers the onset of secretory activation but prolactin, insulin and cortisol must also be present. The pioneer work of scientists that led to our current understanding of the biochemical and endocrinological processes involved in the initiation of human lactation will be discussed together with the factors that control these events and the variation that is observed in the initiation of lactation between women.

### Professor Peter Hartmann PhD



Peter's research has a strong emphasis on the comparative biochemistry of lactation. He has studied milk synthesis and the hormonal control of milk production in cows, ewes, rabbits, rats, goats, sows and quokkas. His research in human lactation began with his daughter's birth in 1971 and his appointment to The University of Western Australia as a lecturer to medical students in 1972. Peter has published extensively on the synthesis and secretion of milk over the entire lactation cycle of women - from conception to weaning. Currently, his research is directed towards understanding the control of milk secretion in women, with the aim of developing clinical protocols for the assessment of the normal function of the lactating breast. In addition, research is

continuing on the assessment of the efficiency of electric breast pumps. His research is highly respected internationally: 2006, he has received the "Macy-Gyorgy Award" by the International Society for Research

Human Milk and Lactation and in 2007 the "La Leche League International Award of Excellence" for contribution to supporting breastfeeding. He has been invited to present his research findings at Conferences in many countries, including the USA, Canada, Mexico, UK, Germany, Netherlands, Italy, Switzerland, Sweden, Norway, France, Japan, Hong Kong, Singapore, Zimbabwe and New Zealand.