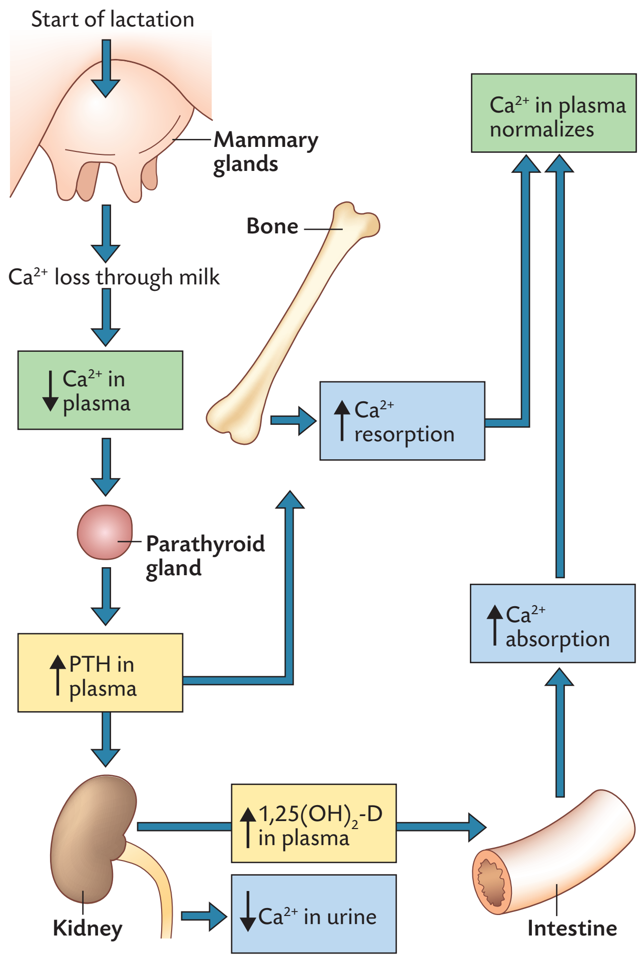

Figure 7.13 Plasma Ca^{2+} homeostasis at the initiation of lactation (cow). When milk secretion begins, large quantities of calcium are transferred to the milk. A decrease in the concentration of Ca^{2+} in the plasma is detected by the parathyroid glands, which increase secretion of PTH. The plasma Ca^{2+} concentration is normalized through increased intestinal Ca^{2+} absorption and increased resorption of Ca^{2+} from bone. Ca^{2+} excretion in the urine is reduced.

milk. This lowers the female's plasma concentrations of these minerals, thus activating homeostatic regulatory mechanisms. The primary homeostatic control of the Ca^{2+} level in the extracellular fluid is shown in Figure 7.13. Substantial amounts of calcium and phosphorous may be mobilized from bone, and must, in turn, be replenished by dietary intake.

Growth hormone increases intestinal absorption of calcium

In addition to the primary hormones regulating calcium and phosphate levels, a number of other hormones affect calcium and phosphate metabolism. Growth hormone increases the absorption of Ca^{2+} from feed, and thus contributes to a positive calcium balance in young, growing animals, while sex steroids inhibit bone resorption and protect against loss of bone tissue and development of osteoporosis. Overproduction of cortisol and long-lasting treatment with natural or synthetic glucocorticoids inhibit the formation of osteoblasts and lead to loss of bone.

Sex steroids inhibit bone resorption and protect against osteoporosis

Ca^{2+}-Transporting Tissues

Many cells, such as intestinal epithelial cells (Fig. 7.14), mammary cells, cells in the fetal part of the placenta, and cells in the shell gland of birds, transport relatively large amounts of Ca^{2+} and phosphate. Because intracellular Ca^{2+} affects many cellular functions, Ca^{2+} must be bound to proteins when it is transported transcellularly, so that the intracellular concentrations of free Ca^{2+} can remain low (Fig. 7.14). It is noteworthy that calcitriol stimulates the synthesis of *Ca^{2+}-binding proteins* in the intestinal epithelium.

Cells performing transcellular Ca^{2+} transport maintain a low intracellular Ca^{2+} concentration by binding Ca^{2+} to proteins

In Ca^{2+}-transporting cells, the apical membrane contains ion channels that allow Ca^{2+} to diffuse into the cell from the extracellular fluid or the intestinal content, whereupon energy-requiring pumps transport Ca^{2+} across the basolateral membrane and into the extracellular fluid (p. 610).

Mammary epithelial cells extract large amounts of Ca^{2+} from the extracellular fluid and transfer Ca^{2+} to milk in both free, ionized form and bound to milk proteins (p. 753). The total concentration of calcium in cows' milk is about 30 mmol/L, of which 3–4 mmol/L are ionized. The concentration of Ca^{2+} in milk is thus about three times higher than that in blood plasma. Also the epithelium of the placenta maintains a Ca^{2+} concentration in fetal blood that is somewhat higher than the Ca^{2+} concentration in maternal blood.

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36 How is calcium transported across intestinal epithelial cells?

37 What is the function of the calcium-binding proteins in Ca^{2+}-transporting cells?