Reduced plasma levels of glucose decrease both lactose synthesis and milk volume

Triglycerides are synthesized in the smooth endoplasmic reticulum

40–50 % of the fatty acids in milk fat are produced in the mammary gland

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36 Which substances are used in the synthesis of lactose?

37 How does prolactin affect lactose synthesis?

prolactin receptors. During the very last stage of pregnancy, prolactin release from the pituitary increases considerably, whereas the release of progesterone from the corpus luteum ceases just prior to parturition. Removal of the progesterone block means that prolactin is then free to stimulate the production of lactose. Because lactose is so important in determining milk volume (p. 863), the elevated concentration of prolactin around parturition contributes directly to the synchronization of parturition and the initiation of milk secretion.

If the plasma concentration of glucose falls below a certain critical level, secretion of lactose ceases and milk volume are greatly reduced. Lactating ruminants are often glucose-deficient when milk production is high, because the udder then uses 70–80 % of the total available glucose. Most (60–70 %) of the glucose taken up by the mammary gland from plasma is used to form lactose, 20–30 % is used to form NADPH for fatty acid synthesis, and a small amount forms α-glycerophosphate used for esterification of fatty acids. Only a small fraction of the glucose taken up by the mammary glands of ruminants is oxidized to form ATP.

Milk Fat

Triglycerides, which are synthesized in the smooth endoplasmic reticulum of the alveolar cells from precursor fatty acids and glycerol, coalesce into droplets that move to the apical membrane. As noted, the droplet protrudes into the alveolar lumen and gradually becomes enveloped by apical cell membrane. The membrane-lined droplet is finally pinched off from the cell and enters the lumen. The membrane coat of a fat globule has two functions. Firstly, it provides dietary phospholipids and cholesterol for the neonate. Secondly, it prevents fat globules from coalescing into larger fat drops.

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38 How are triglycerides transported from the epithelial cells and into the alveolar lumen?

39 What are the functional roles of the membrane surrounding the triglyceride droplets in milk?

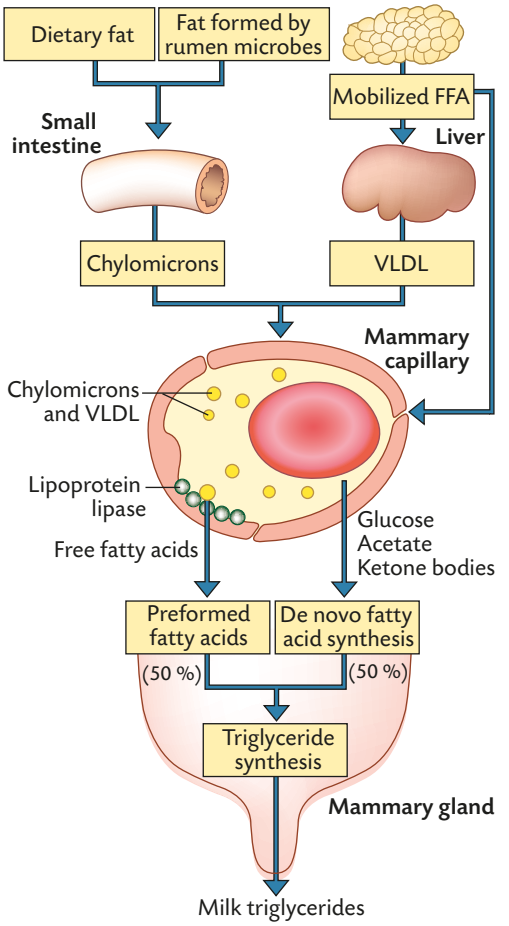

Figure 20.8 Precursors for the lipids that are synthesized and secreted by mammary epithelial cells. The lipids are derived from the diet and from adipose tissue. In ruminants, the fatty acids are not synthesized from glucose.

In most domestic animals, 40–50 % of the fatty acids used by the mammary gland for fat synthesis are produced in the mammary epithelial cells by synthesis from smaller components (*de novo* synthesis), such as acetate in ruminants and glucose in simple-stomached animals. The other half, the *preformed fatty acids*, originate from triglycerides in circulating chylomicrons or very low-density lipoproteins (VLDL, Fig 20.8). These fatty acids are taken up from the blood subsequent to degradation of the triglycerides to free fatty acids and glycerol by the enzyme lipoprotein lipase in the capillary wall (p. 730). Palmitic acid (C16:0) accounts for approximately one third of the fatty acids taken up from the blood, whereas most of the remaining preformed acids have a chain length of 18 carbon atoms (stearic, oleic, and linoleic acids). Both preformed fatty acids and acids produced by the mammary epithelial cells are esterified by glycerol in the alveolar cells (Fig. 20.8, triglyceride synthesis).

In ruminants, more than 90 % of triglycerides and other plant lipids in feed are hydrolyzed in the rumen. Grasses contain mostly α-linolenic acid (C18:3), whereas grains contain primar-