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34 Which substances are used in the synthesis of lactose?

35 How does prolactin affect lactose synthesis?

A reduction in the plasma level of glucose reduces both lactose synthesis and milk volume

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

In the forestomachs, dietary fatty acids become saturated

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

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

If the plasma concentration of glucose falls below a certain critical level, secretion of lactose ceases and milk volume is 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. Sixty to seventy percent 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 large droplets that move to the apical membrane. The droplets protrude into the alveolar lumen and gradually become enveloped by apical cell membrane, finally separating from the cell. The membrane surrounding a fat globule has two functions. Firstly, it provides dietary phospholipids and cholesterol for the neonate, and, secondly, it prevents fat globules from coalescing into large fat drops.

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 from smaller components (*de novo* synthesis), such as acetate in ruminants and glucose in single-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. 624). Palmitic acid (C16:0) accounts for approximately one third of the fatty acids taken up from the blood, while most of the remaining preformed acids have a carbon chain length of 18 (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 primarily linoleic acid (C18:2) and oleic acid (C18:1). More than 90 % of these unsaturated fatty acids are completely hydrogenated in the forestomachs, forming stearic acid (C18:0).

In simple-stomached animals, there is no hydrogenation of unsaturated fatty acids in the digestive tract. The fatty acid composition of milk fat therefore reflects the fatty acid composition of the feed to a greater extent than in ruminants. If the fat in the feed is rich in polyunsaturated fatty acids, the milk fat of non-ruminants will also have a high content of polyunsaturated fatty acids.

Figure 20.8 Precursors for the fatty acids used in triglyceride synthesis in the mammary glands. About 50 % of the fatty acids are derived from the diet and from adipose tissue, while the other half is synthesized in the mammary glands. In ruminants, glucose is not used for synthesis of fatty acids

