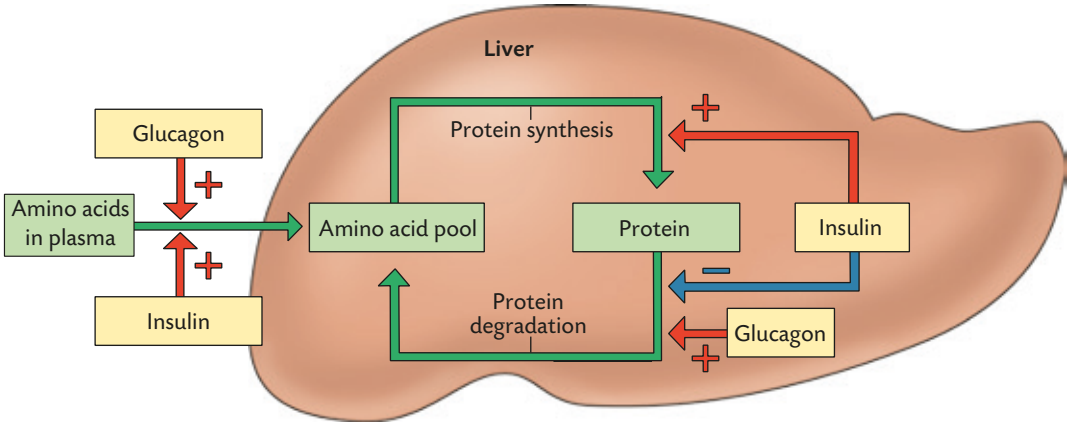

Figure 16.13 The effects of insulin and glucagon on protein metabolism in the liver. The effects of insulin are identical to those on muscle cells (Fig. 16.9). Both insulin and glucagon stimulate the transport of amino acids into hepatocytes, but they have opposing effects on protein degradation.

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55 How does the concentration of amino acids in plasma affect insulin and glucagon secretion?

56 Which factors stimulate release of glucagon?

Epinephrine (Adrenaline) and the Sympathetic Nervous System

The effects of the sympathetic nervous system on metabolism are important in situations of stress

A decrease in the concentration of glucose in plasma, as occurs in the postabsorptive state, increases the activity of sympathetic neurons and triggers a rise in catecholamine secretion from the adrenal medulla. However, the sympathetic system is of lesser importance than insulin and glucagon for inducing alterations in energy metabolism associated with normal feeding regimes. On the other hand, the effects of the sympathetic nervous system on metabolism are important in situations of stress, for example strenuous exercise.

The insulin/glucagon ratio is reduced by increased sympathetic activity. However, the increased mobilization of energy stores during physical activity is not only due to a reduction in this ratio. Both elevated concentrations of epinephrine in plasma and increased activity in sympathetic nerve fibers to the liver and adipose tissue also exert direct metabolic effects. Epinephrine is a very potent stimulator of glycogenolysis in the liver, thereby releasing large quantities of glucose into the blood (Fig. 16.14). In addition, under the influence of the sympathetic nervous system, adipose tissue exports large amounts of fatty acids to the blood, because epinephrine stimulates the hormone-sensitive lipase (Fig. 16.11). During maximal work, the concentrations of fatty acids may increase 5–10-fold, thus by far exceeding the increase in glucose concentration. The cellular consumption of free fatty acids, which is proportional to their concentration in plasma, is extensive in many stressful situations. Many of the effects of epinephrine on metabolism are the same as those of glucagon: the concentration of glucose in plasma increases (Fig. 16.14) and fatty acids are mobilized from adipocytes and oxidized in other cells (Fig. 16.11). However, in contrast to glucagon, epinephrine does not stimulate gluconeogenesis.

Epinephrine is a potent inducer of glycogenolysis

Epinephrine stimulates the hormone-sensitive lipase, thus mobilizing fatty acids

Glucocorticoids

Cortisol is of little importance in energy metabolism during normal, quiet conditions. Cortisol is nevertheless a vital hormone, because, in its absence, the glucose concentration in plasma drops dramatically during long-term starvation and stress.

Glucocorticoids are essential for gluconeogenesis and lipolysis during starvation

When the concentration of glucose drops below its normal plasma level, the formation of cortisol in the adrenal glands increases. The most important effect of cortisol is to stimulate gluconeogenesis in the liver. The main reason for this effect is the ability of cortisol to increase mobilization of amino acids from all cells, with the exception of the hepatocytes. In this way, the supply of amino acids that can be utilized in the hepatic synthesis of glucose is increased. In