THE FEED-FAST CYCLE

OVERVIEW OF THE ABSORPTIVE PHASE

- The absorptive (well-fed) state is **2-4 hrs period after ingestion of a normal meal**
- During this interval, transient increases in plasma glucose, amino acids and TAG is seen
- Islet tissue of pancreas responds to **elevated level of glucose with increased secretion of insulin** and decreased secretion of glucagon
- The elevated insulin/glucagon ratio and the ready availability of circulating substrates make the absorptive state an **anabolic period** characterized by increase synthesis of TAG and glycogen as well as increased synthesis of protein

- During this absorptive period, virtually all tissues use **glucose as a fuel**, and metabolic response of the body is dominated by alterations in the metabolism of **liver, adipose tissue, skeletal muscle and brain**

LIVER:NUTRITION DISTRIBUTION CENTER

- The liver is uniquely situated to process and distribute dietary nutrients because the **venous drainage of the gut and pancreas passes through the hepatic portal vein** before entry in to general circulation
- Thus, after a meal, the liver is bathed in blood containing absorbed nutrients and elevated levels of insulin secreted by pancreas
- During the absorptive phase, the liver takes up carbohydrates, lipids and most amino acids

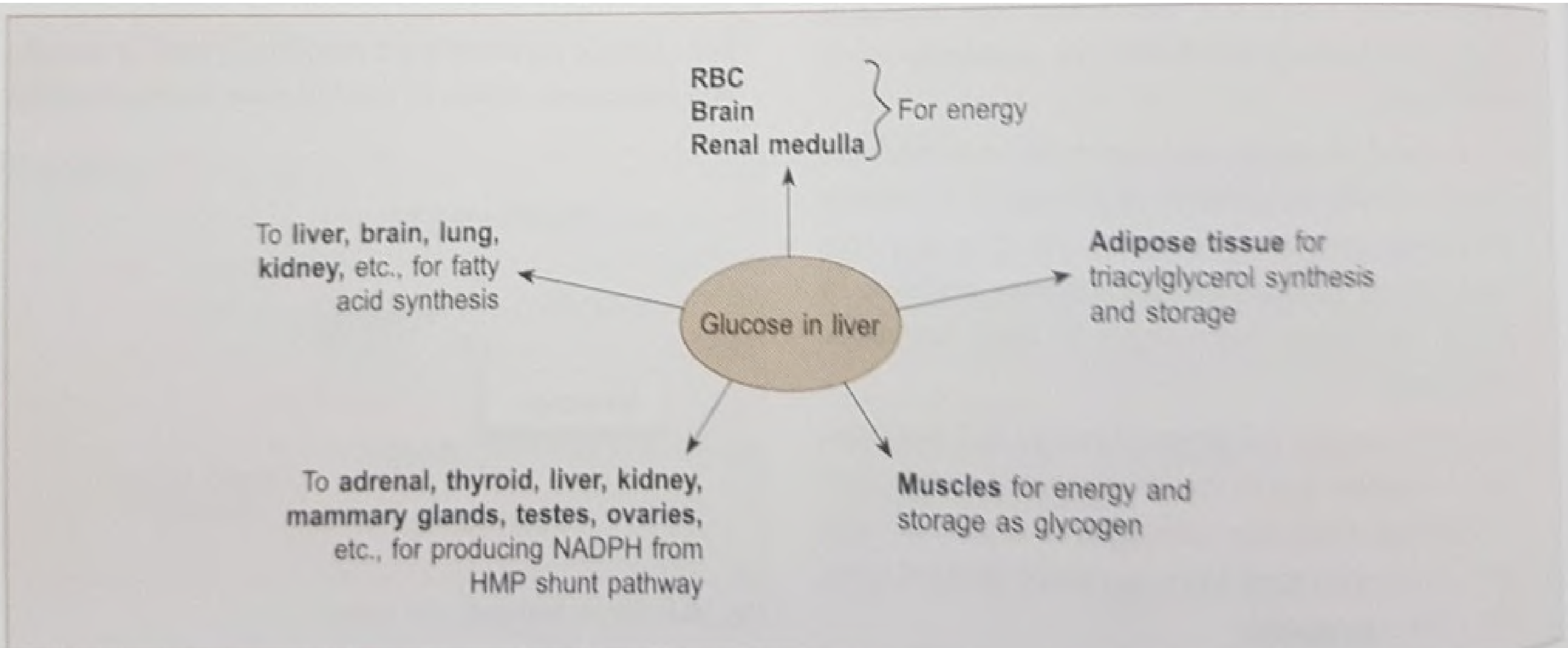


Fig. 30.3: Fate of dietary glucose

ADIPOSE TISSUE: ENERGY STORAGE DEPOT

- Adipose is **second only to liver** in its ability to distribute fuel molecule
- In a 70 kg man, white adipose tissue weighs **around 14 kg** or about half as much as total muscle mass
- Nearly the entire volume of each adipocyte in WAT can be occupied by **anhydrous,calorically dense TAG**

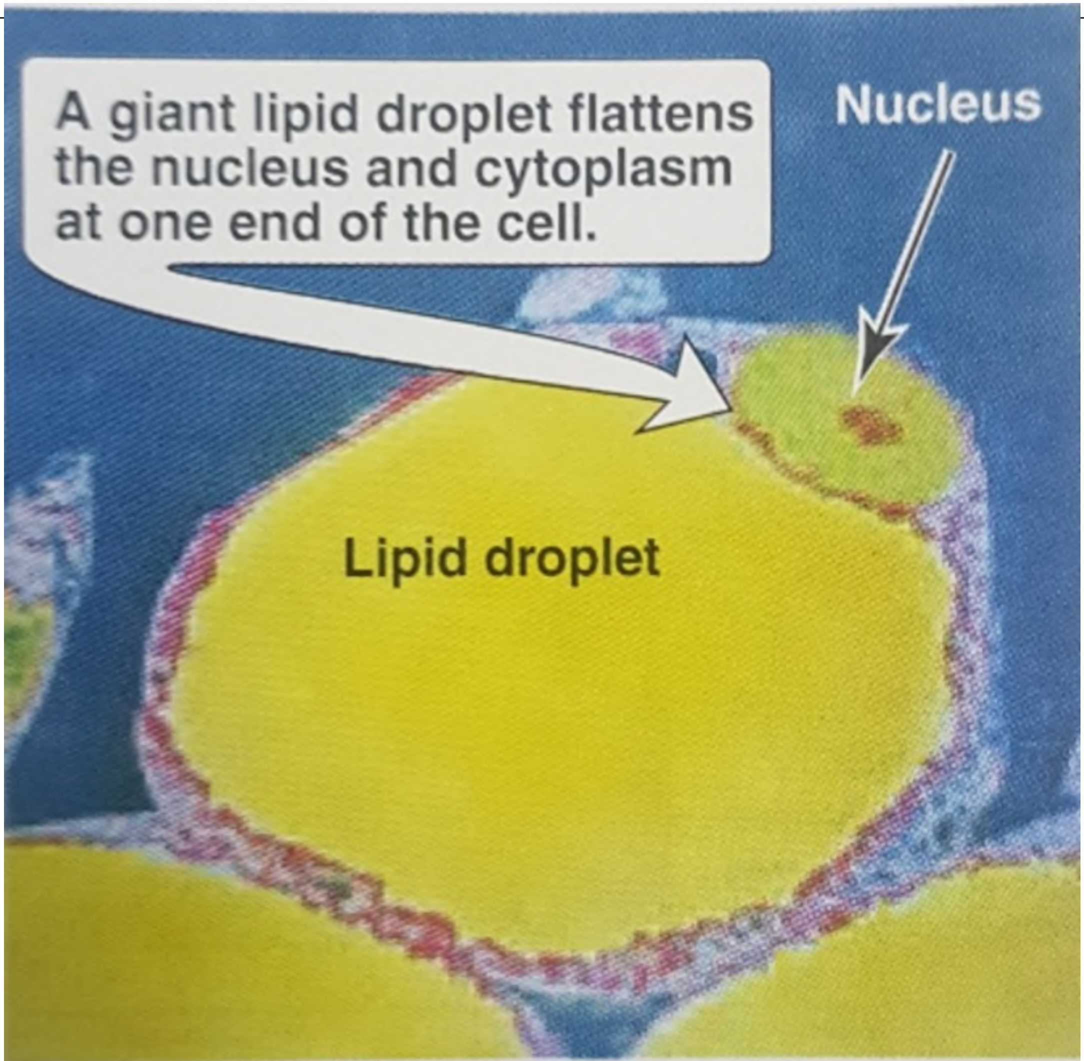


Figure 24.5

Colorized transmission electron micrograph of adipocytes.

SKELETAL MUSCLE

- Skeletal muscle accounts for **nearly 40% of the body mass in individuals** of healthy weight and it can use glucose, amino acids, and ketone bodies as fuel.
- Skeletal muscle is unique in being able to respond to substantial changes in the demand for ATP that accompanies muscle contraction
- At rest, muscle accounts for **25% of oxygen consumption of the body** ,whereas during vigorous exercise ,it is responsible for up to **90% of total oxygen consumed**

BRAIN

- Although contributing only 2% of adult weight, brain accounts for a consistent **20% of basal oxygen consumption of the body** at rest

- **In the fed state**, brain **exclusively uses glucose as a fuel** ,completely oxidising 140g/day to carbon dioxide and water

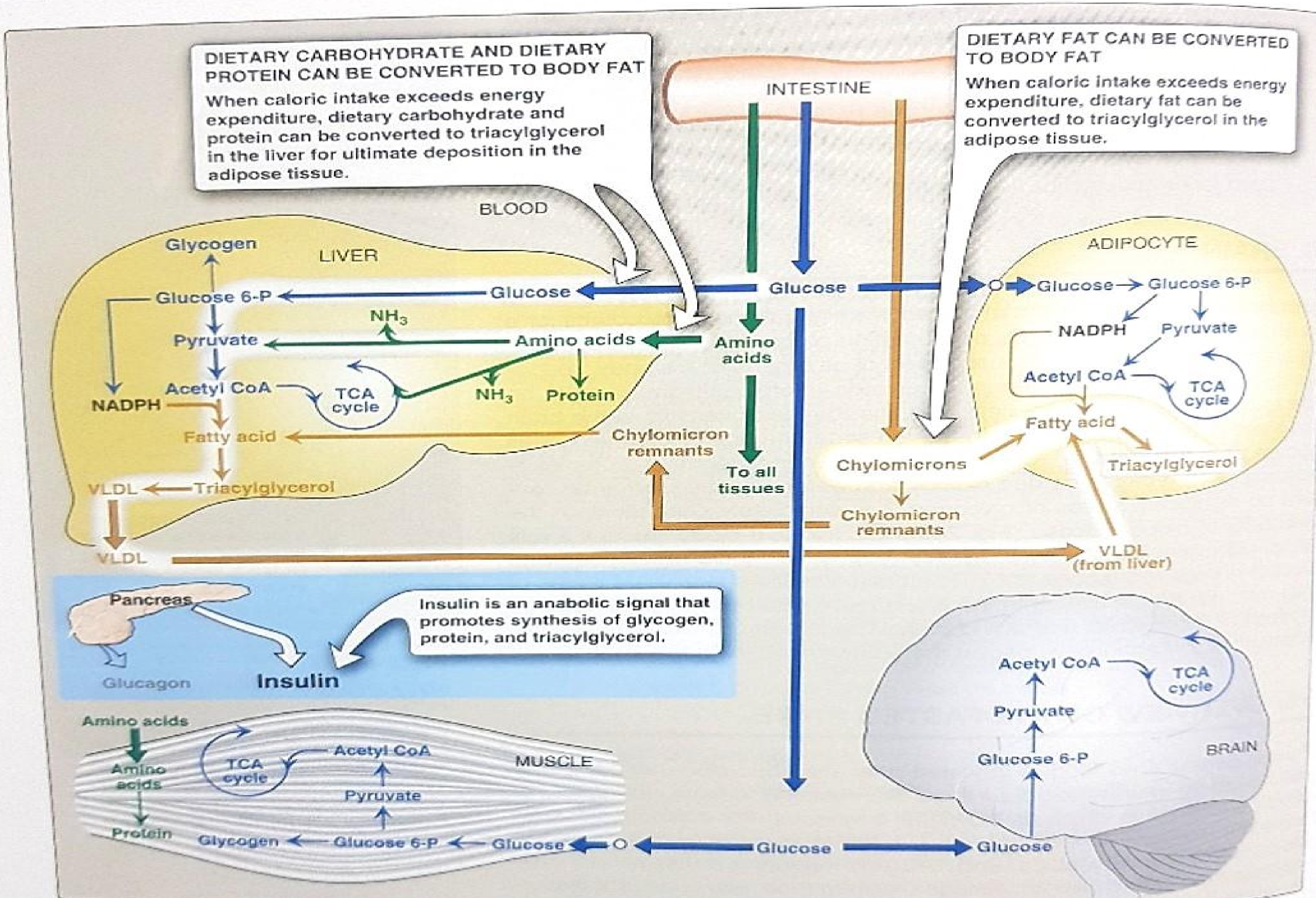
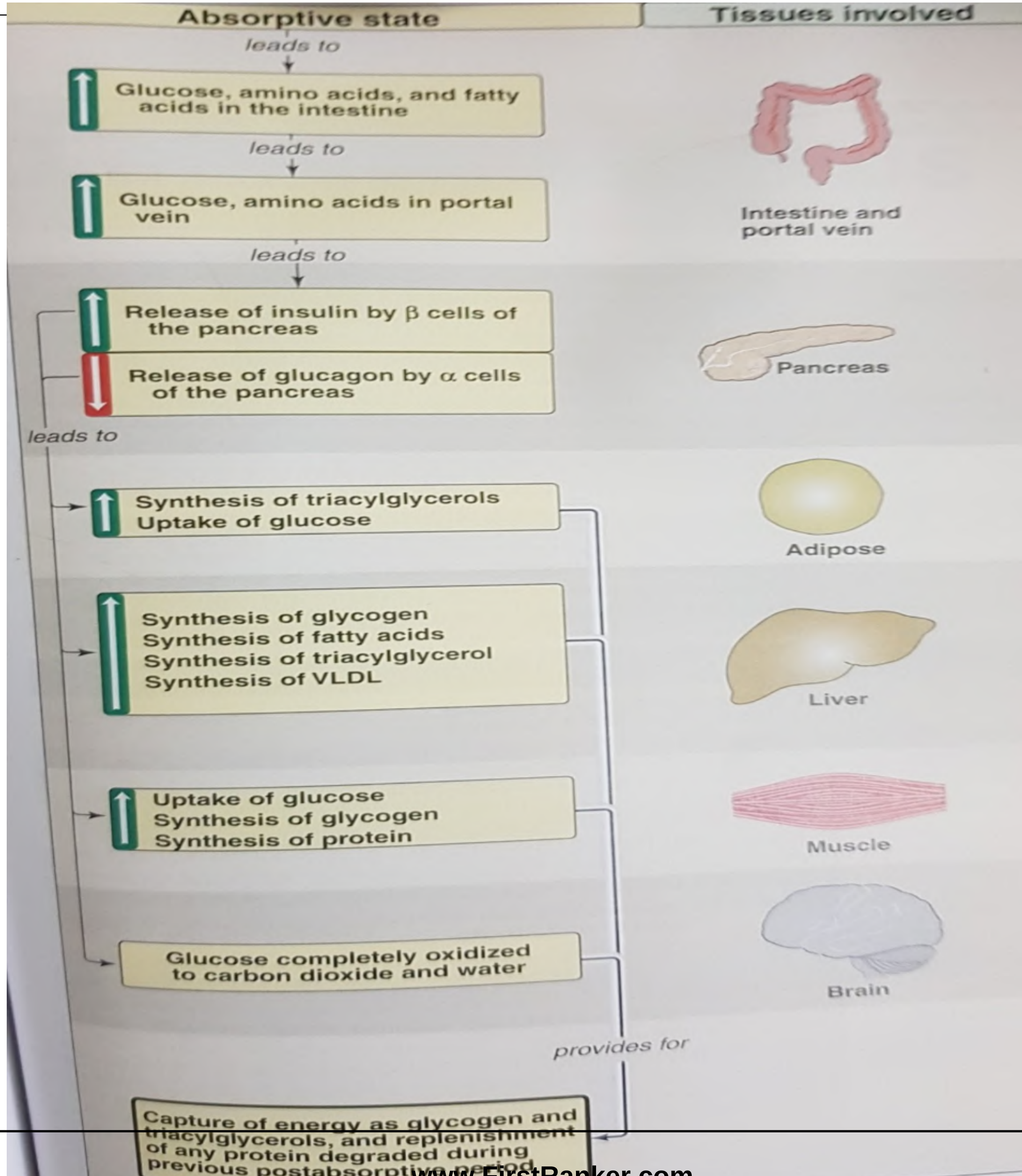


Figure 24.9
Intertissue relationships in the absorptive state and the hormonal signals that promote them. [Note: Small circles on the perimeter of muscle and the adipocyte indicate insulin-dependent glucose transporters.] P = phosphate; CoA = coenzyme A; NADPH = nicotinamide adenine dinucleotide phosphate; TCA = tricarboxylic acid; VLDL = very-low-density lipoprotein.


Absorptive state
Tissues involved
leads to
Glucose, amino acids, and fatty acids in the intestine
leads to
Glucose, amino acids in portal vein
Intestine and portal vein
leads to
Release of insulin by β cells of the pancreas
Release of glucagon by α cells of the pancreas
Pancreas
leads to
Synthesis of triacylglycerols
Uptake of glucose
Adipose
Synthesis of glycogen
Synthesis of fatty acids
Synthesis of triacylglycerol
Synthesis of VLDL
Liver
Uptake of glucose
Synthesis of glycogen
Synthesis of protein
Muscle
Glucose completely oxidized to carbon dioxide and water
Brain
provides for
Capture of energy as glycogen and triacylglycerols, and replenishment of any protein degraded during previous postabsorptive period

OVERVIEW OF FASTING STAGE

- Fasting begins if **no food is ingested after the absorptive period**
- It may result from inability to obtain food, the desire to lose weight or clinical situation in which an individual can not eat
- In the absence of food, **plasma level of glucose falls**, triggering a **decline in insulin secretion and increase in glucagon, epinephrine and cortisol secretion**
- **Decrease insulin/glucagon ratio** and decreased availability of circulating substrates make the postabsorptive period a **catabolic period** characterized by degradation of glycogen, TAG and protein

Starve cycle is divided in two four stages:

- **Early fasting** (4-16 hrs after food)
- **Prolonged Fasting** (16-48 hrs after food)
- **Starvation** (2-3 days without food)
- **Prolonged starvation** (>5 days without food)

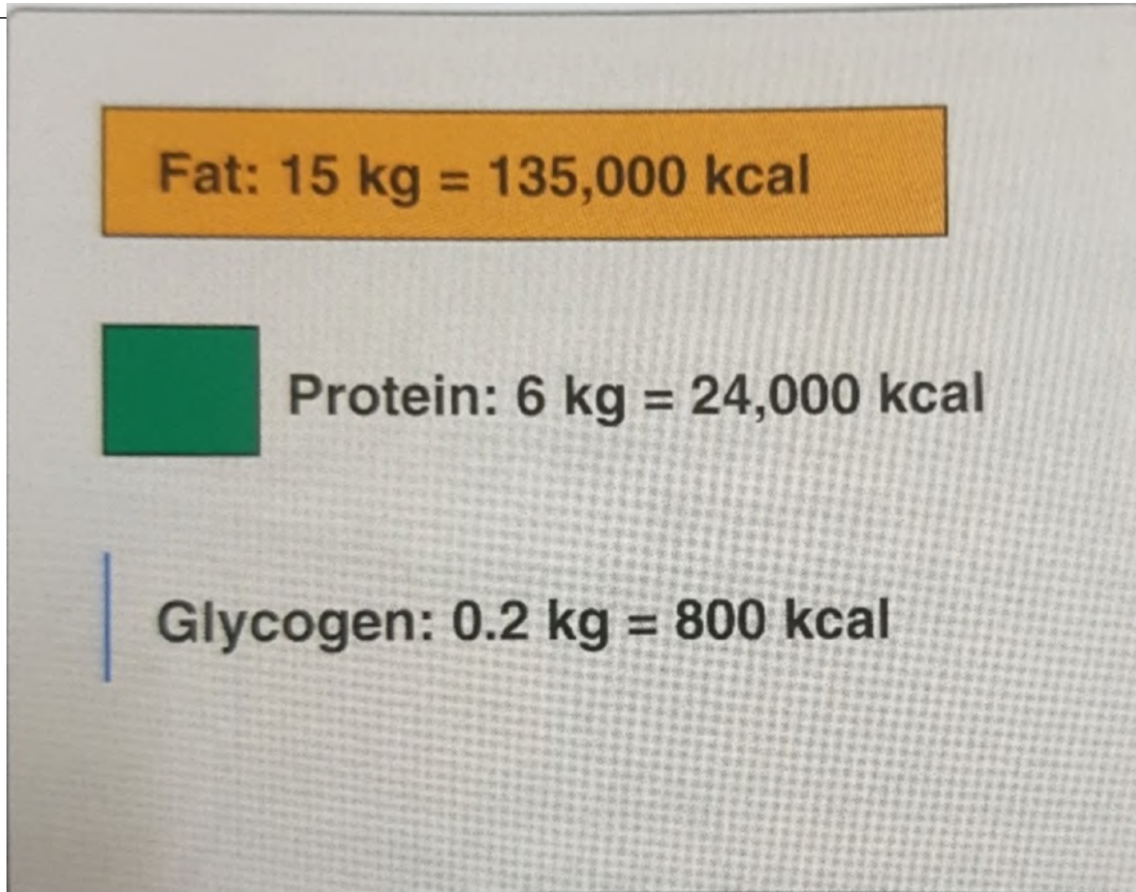


Figure 24.10

Metabolic fuels present in a 70-kg man at the beginning of a fast. The fat stores are sufficient to meet energy needs for ~80 days.

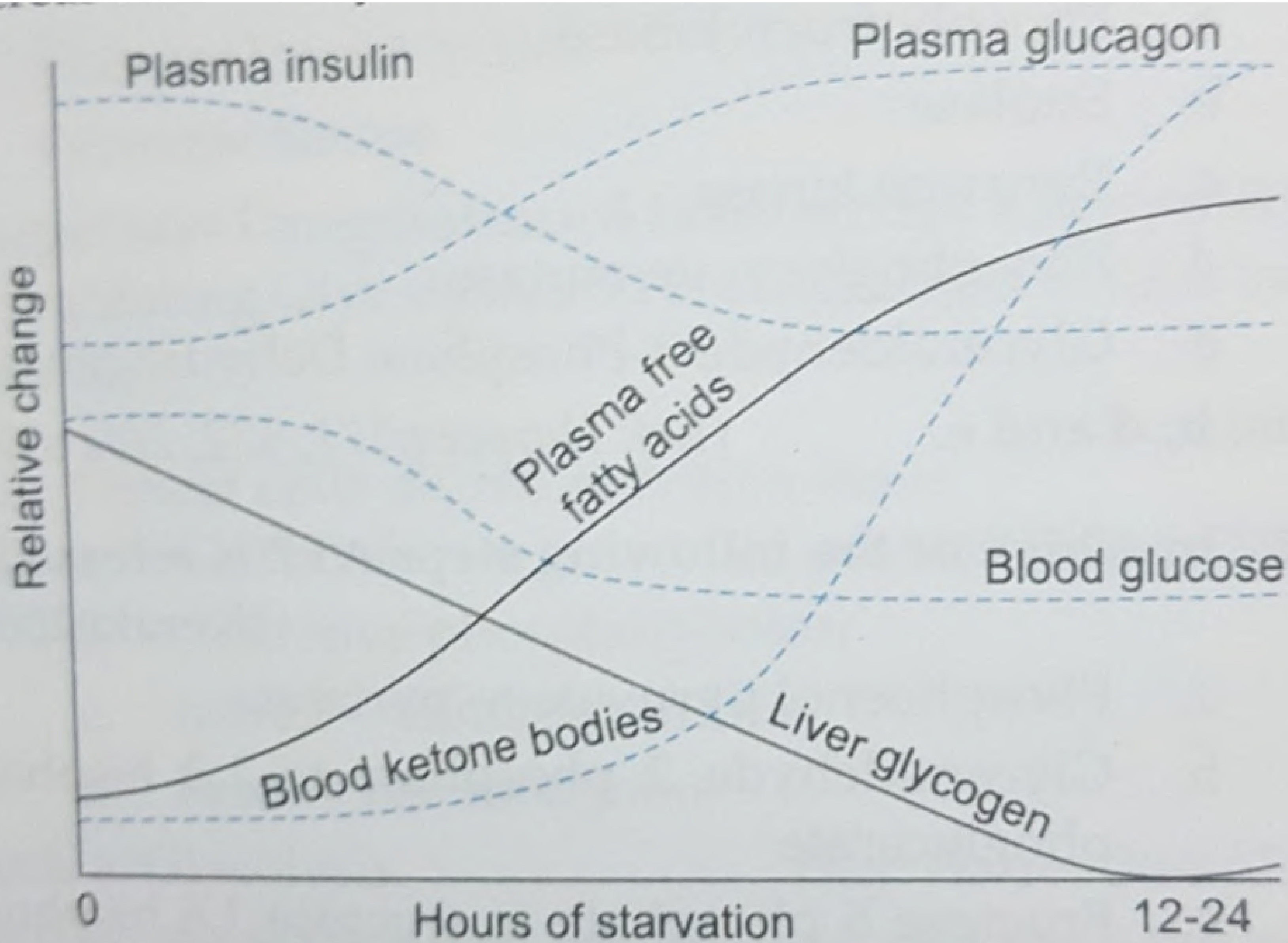


Fig. 5.21: Biochemical changes in fasting

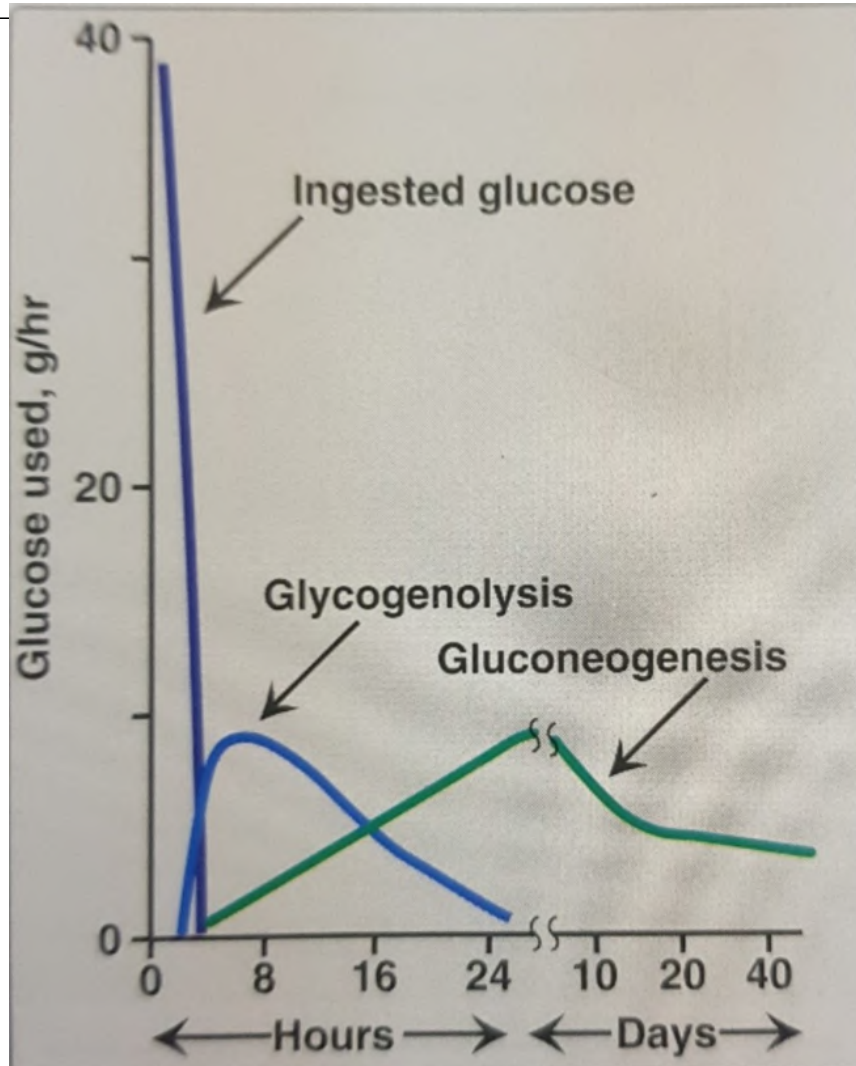


Figure 24.11

Sources of blood glucose after ingestion of 100 g of glucose. [Note: See Section B.2 for an explanation of the decline in gluconeogenesis.]

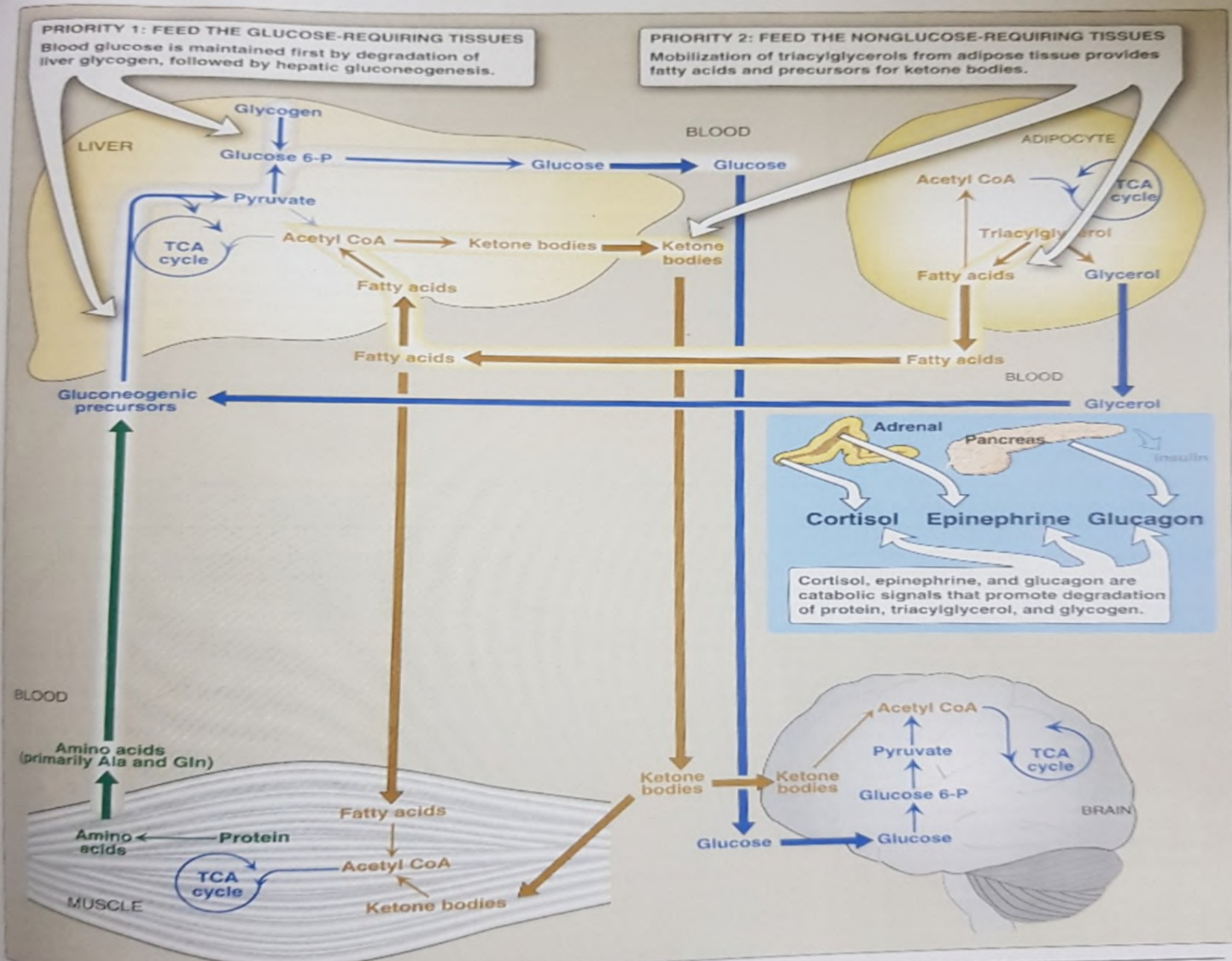


Figure 24.18
Intertissue relationships during fasting and the hormonal signals that promote them. P = phosphate; TCA = tricarboxylic acid.

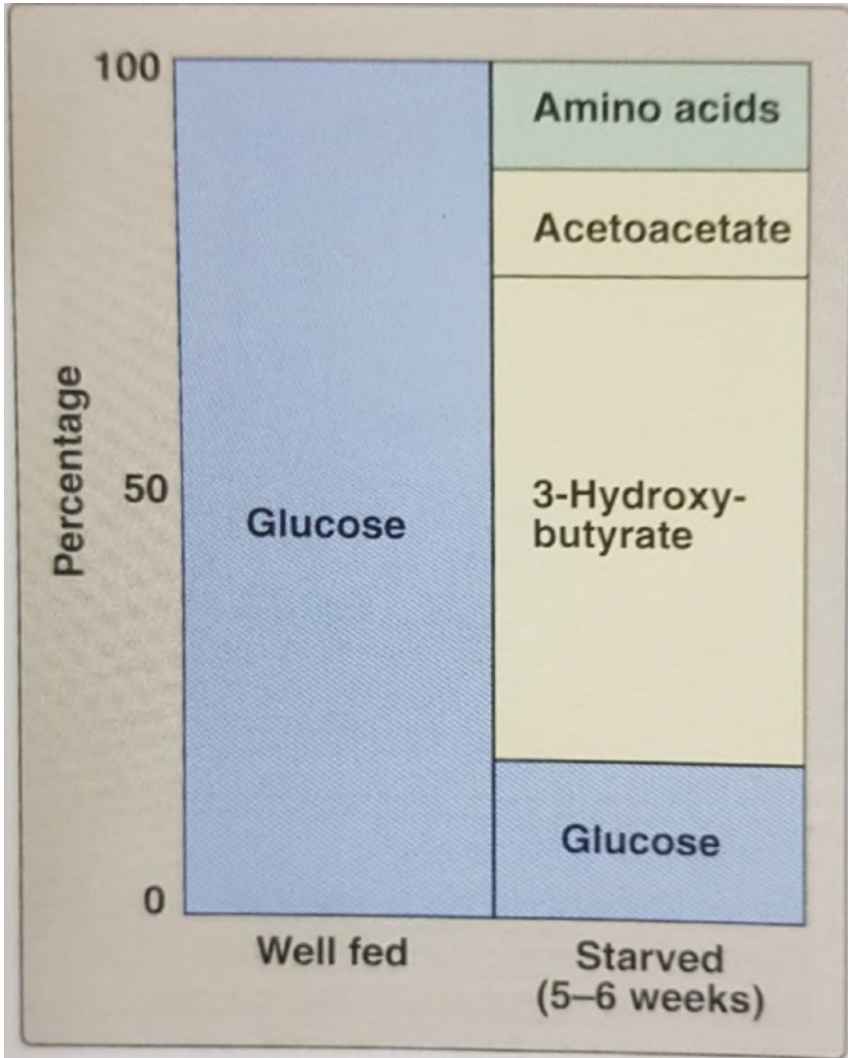
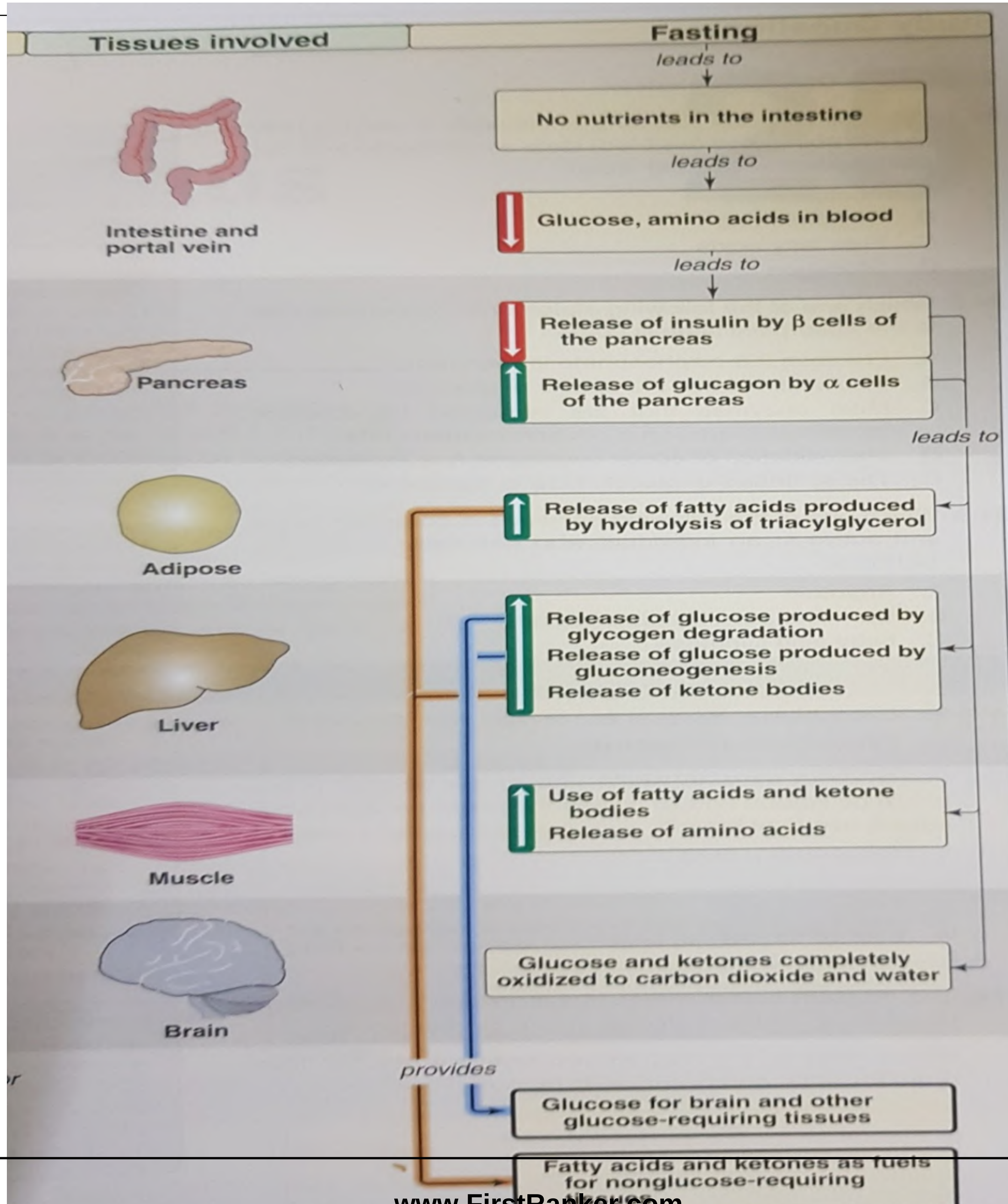


Figure 24.17
Fuel sources used by the brain to meet energy needs in the well-fed and starved states.


Tissues involved
Fasting
leads to
No nutrients in the intestine
leads to
Glucose, amino acids in blood
leads to
Intestine and portal vein
Release of insulin by β cells of the pancreas
Release of glucagon by α cells of the pancreas
Pancreas
leads to
Release of fatty acids produced by hydrolysis of triacylglycerol
Adipose
Release of glucose produced by glycogen degradation
Release of glucose produced by gluconeogenesis
Release of ketone bodies
Liver
Use of fatty acids and ketone bodies
Release of amino acids
Muscle
Glucose and ketones completely oxidized to carbon dioxide and water
Brain
provides
Glucose for brain and other glucose-requiring tissues
Fatty acids and ketones as fuels for nonglucose-requiring

INTEGRATION OF METABOLISM

Major Metabolic Fuel of Major Organs[Q]

Organ	Major metabolic fuels
Liver	Free fatty acids, glucose (in fed state), lactate, glycerol, fructose, amino acids, alcohol
Brain	Glucose, amino acids, ketone bodies in prolonged starvation
Heart[Q]	Ketone bodies, free fatty acids, lactate, chylomicron and VLDL triacylglycerol, some glucose
Adipose tissue	Glucose, chylomicron and VLDL triacylglycerol
Fast Twitch Muscle	Glucose, glycogen
Slow Twitch Muscle	Ketone bodies, chylomicron and VLDL triacylglycerol
Kidney	Free fatty acids, lactate, glycerol, glucose
Erythrocyte	Glucose