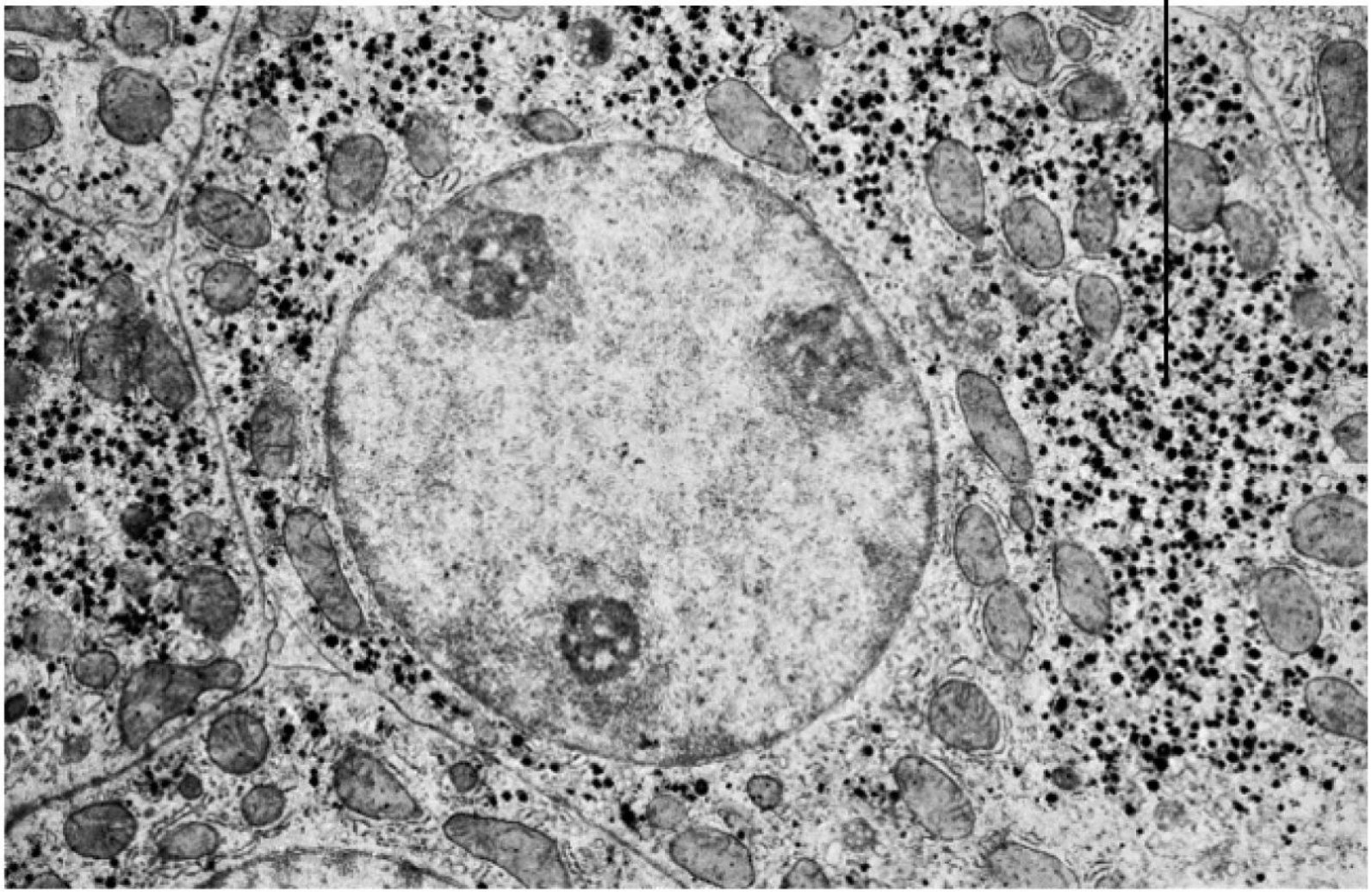
Biochemistry

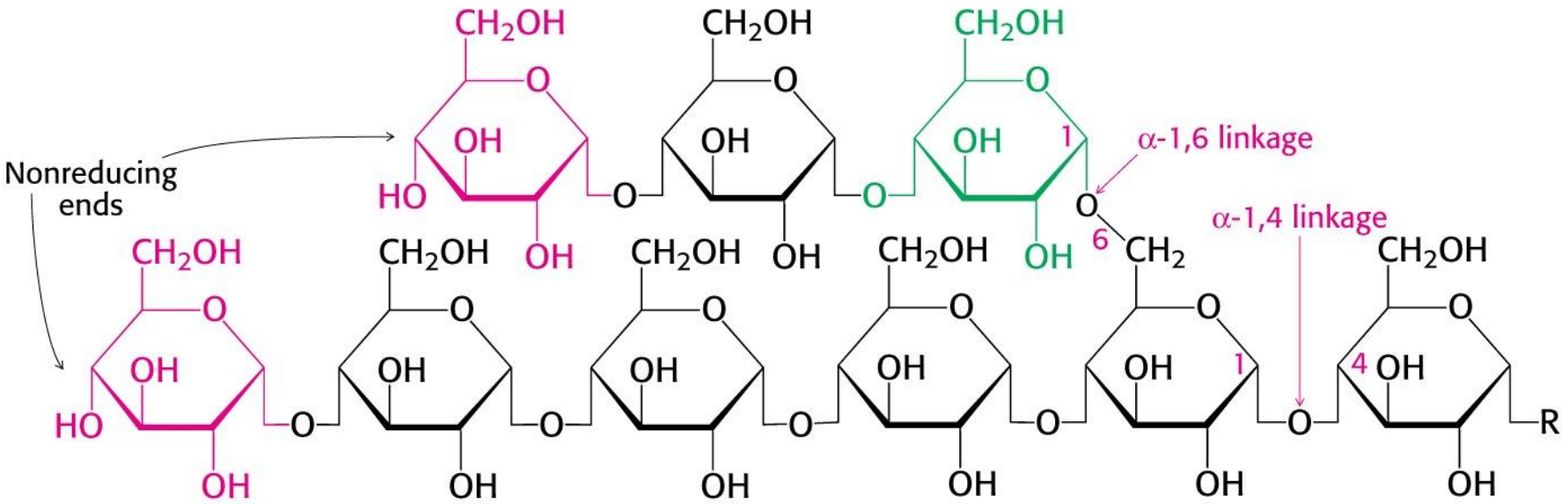
Carbohydrate metabolism II.

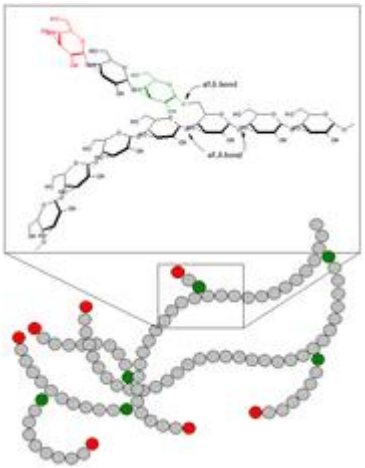
Glycogen granules

~55,000 glucose → β-particle; 20-40 β-particle → α-rosettes

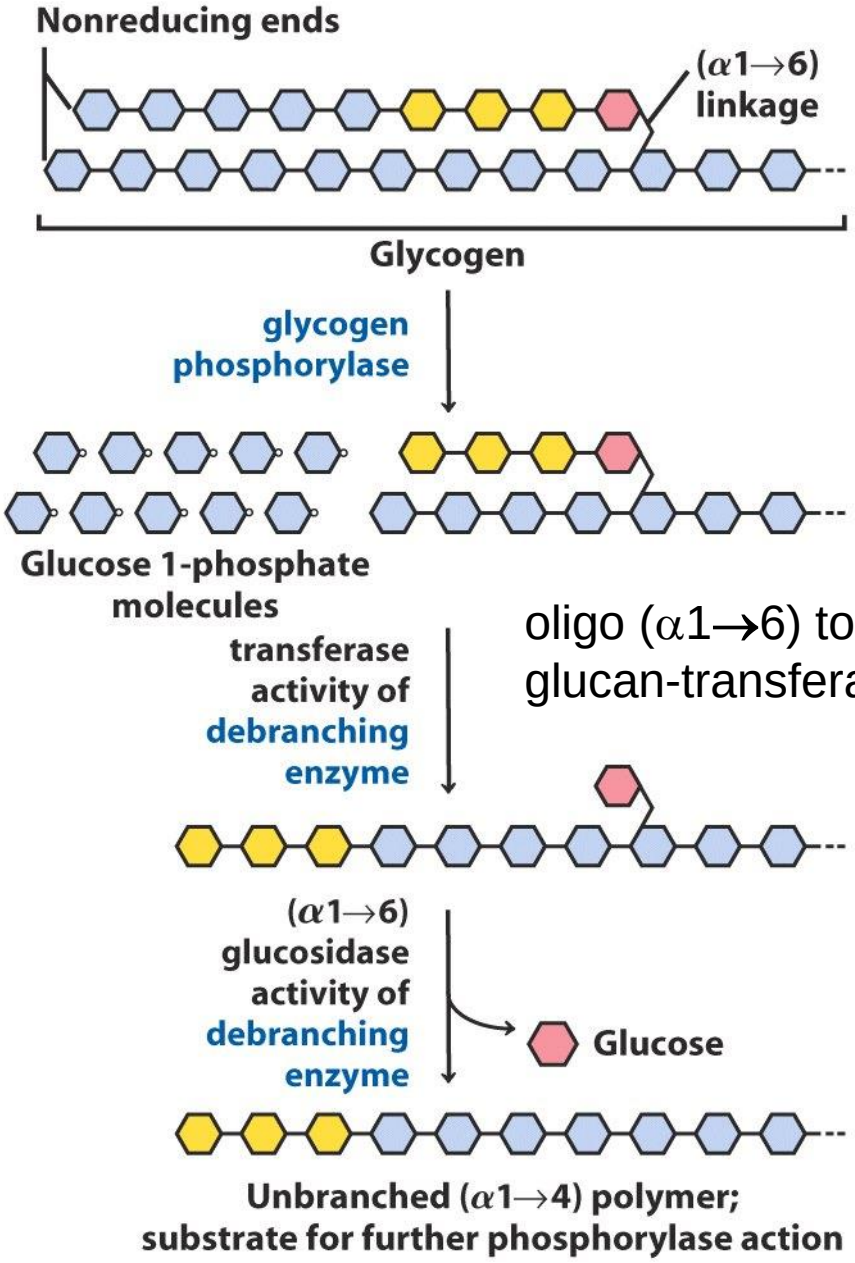


Structure of glycogen

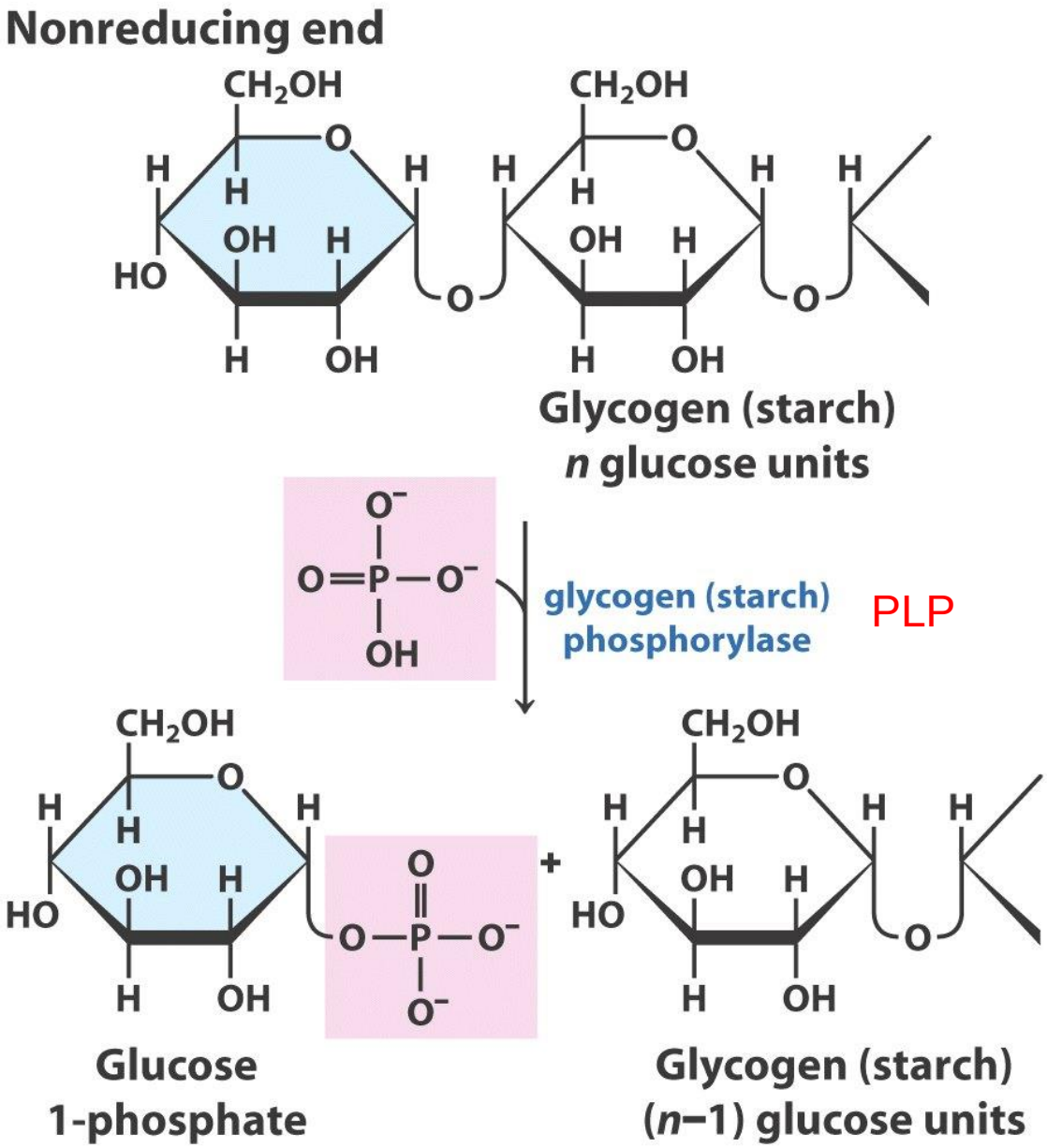




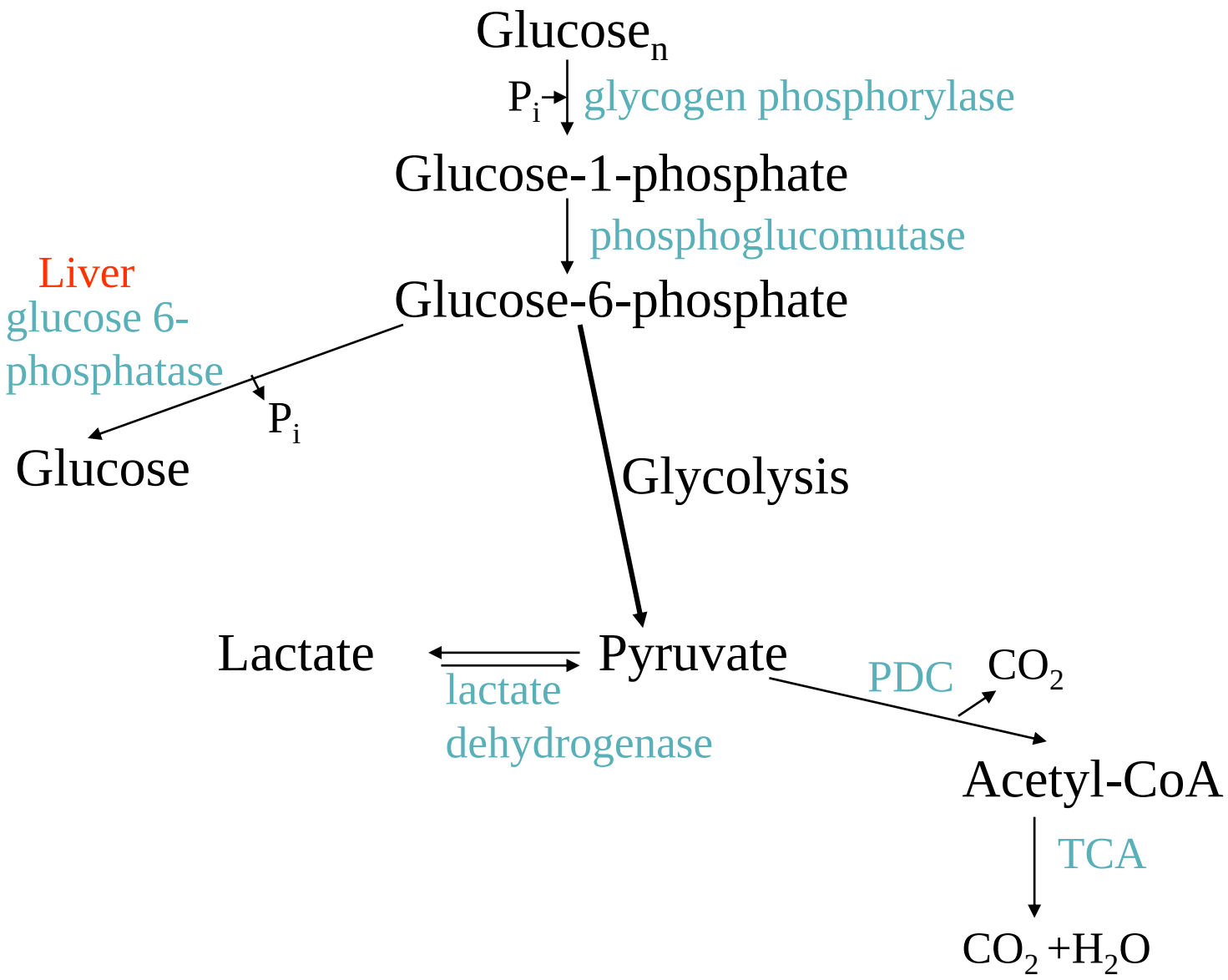
Glycogen breakdown



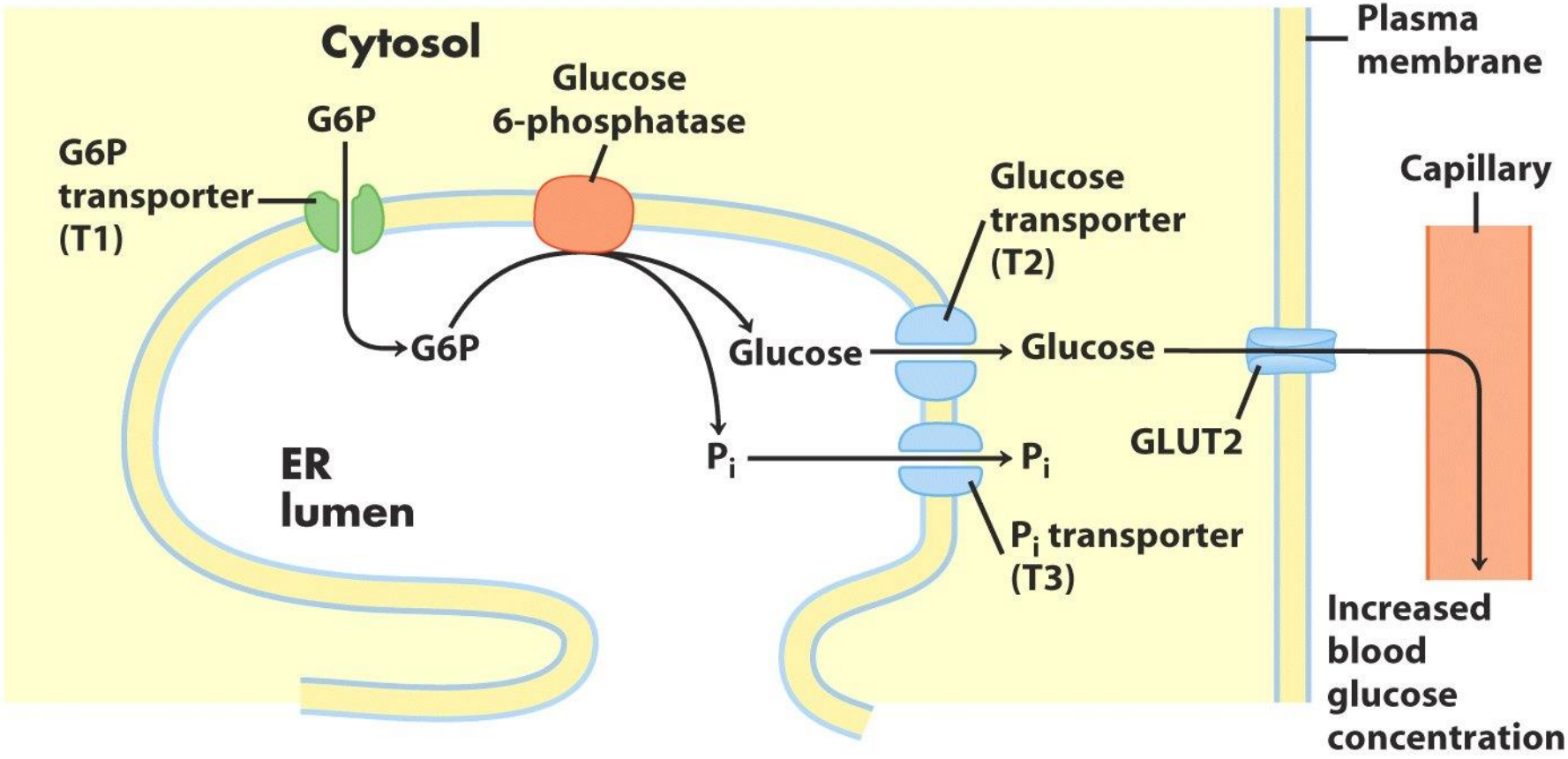
Glycogen breakdown



Glycogen breakdown



Glucose 6-phosphatase



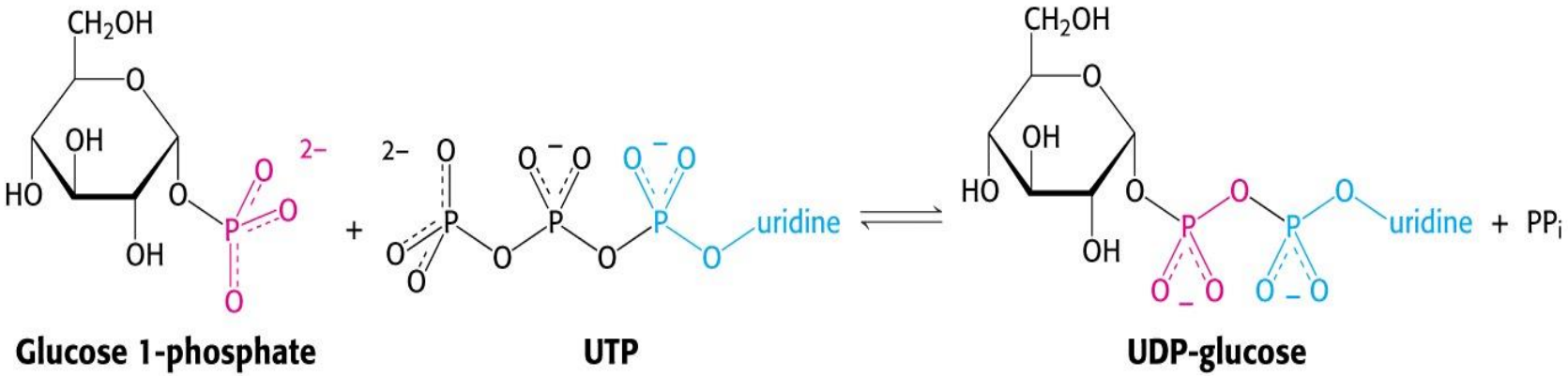
Glycogen synthesis

Muscle, liver:
glucose + ATP → glucose-6-phosphate + ADP (hexokinase, glucokinase)

Erythrocyte, liver:
glucose → lactate → glucose-6-phosphate

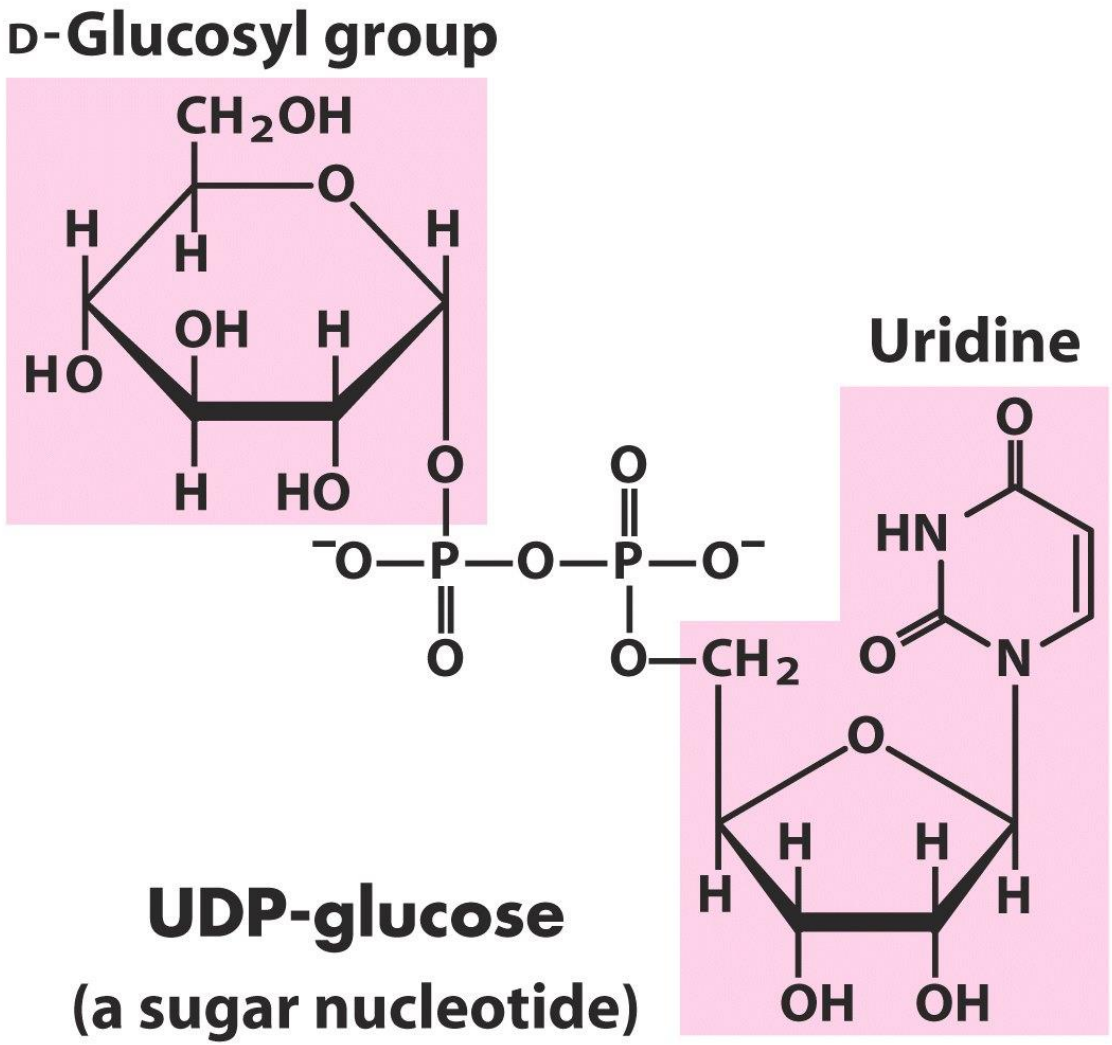
glucose-6-phosphate ↔glucose-1-phosphate (phosphoglucomutase)

glucose-1-phosphate + UTP → UDP-glucose + PP_i (UDP-glucose pyrophosphorylase)

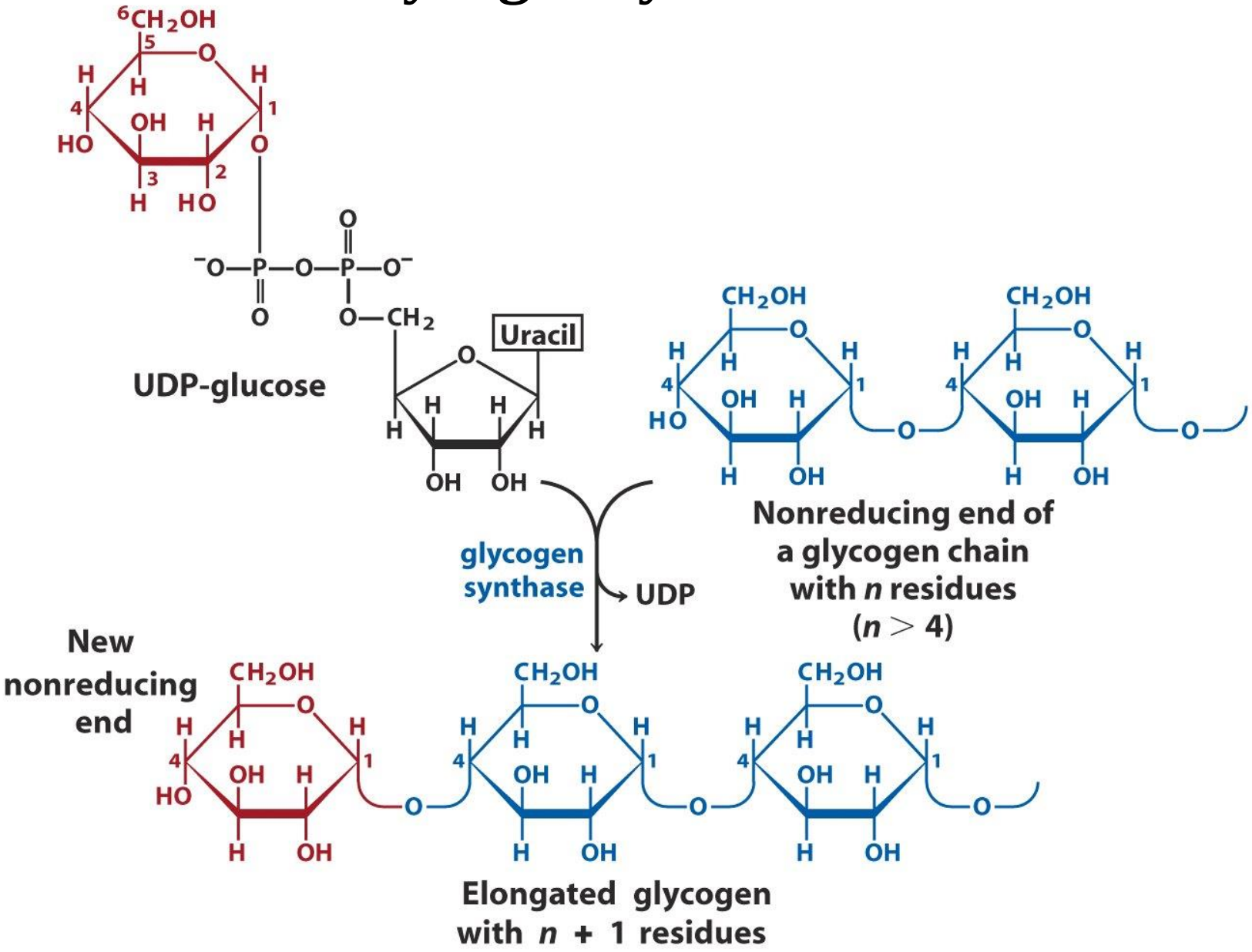


Glucose 1-phosphate UTP UDP-glucose

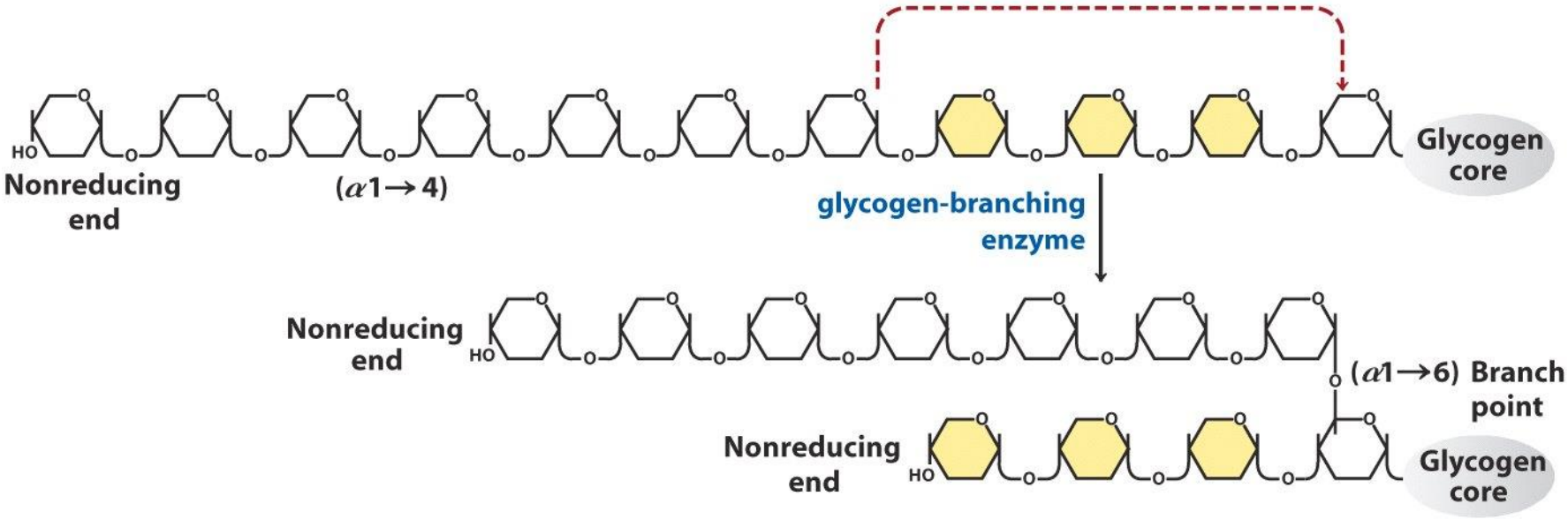
Structure of UDP-glucose



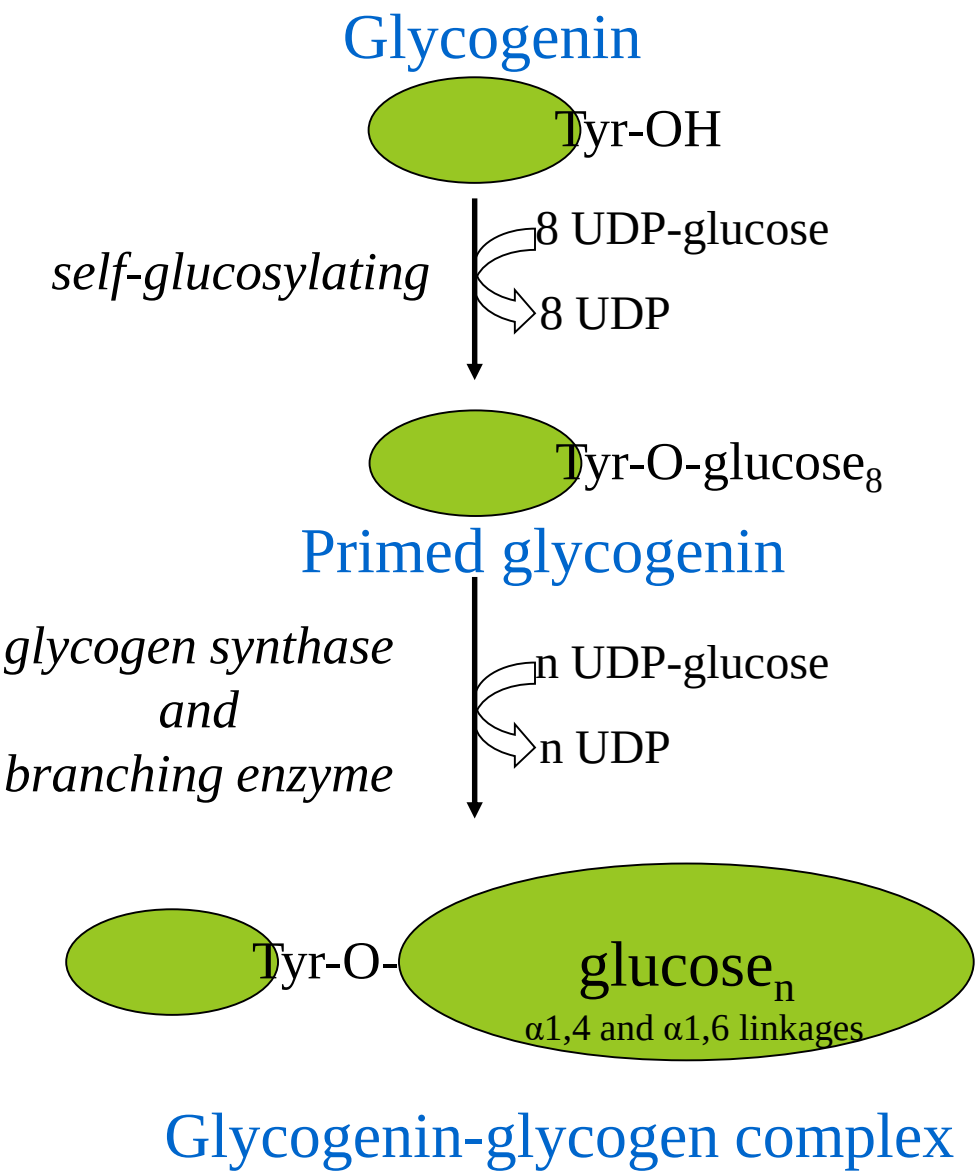
Glycogen synthesis



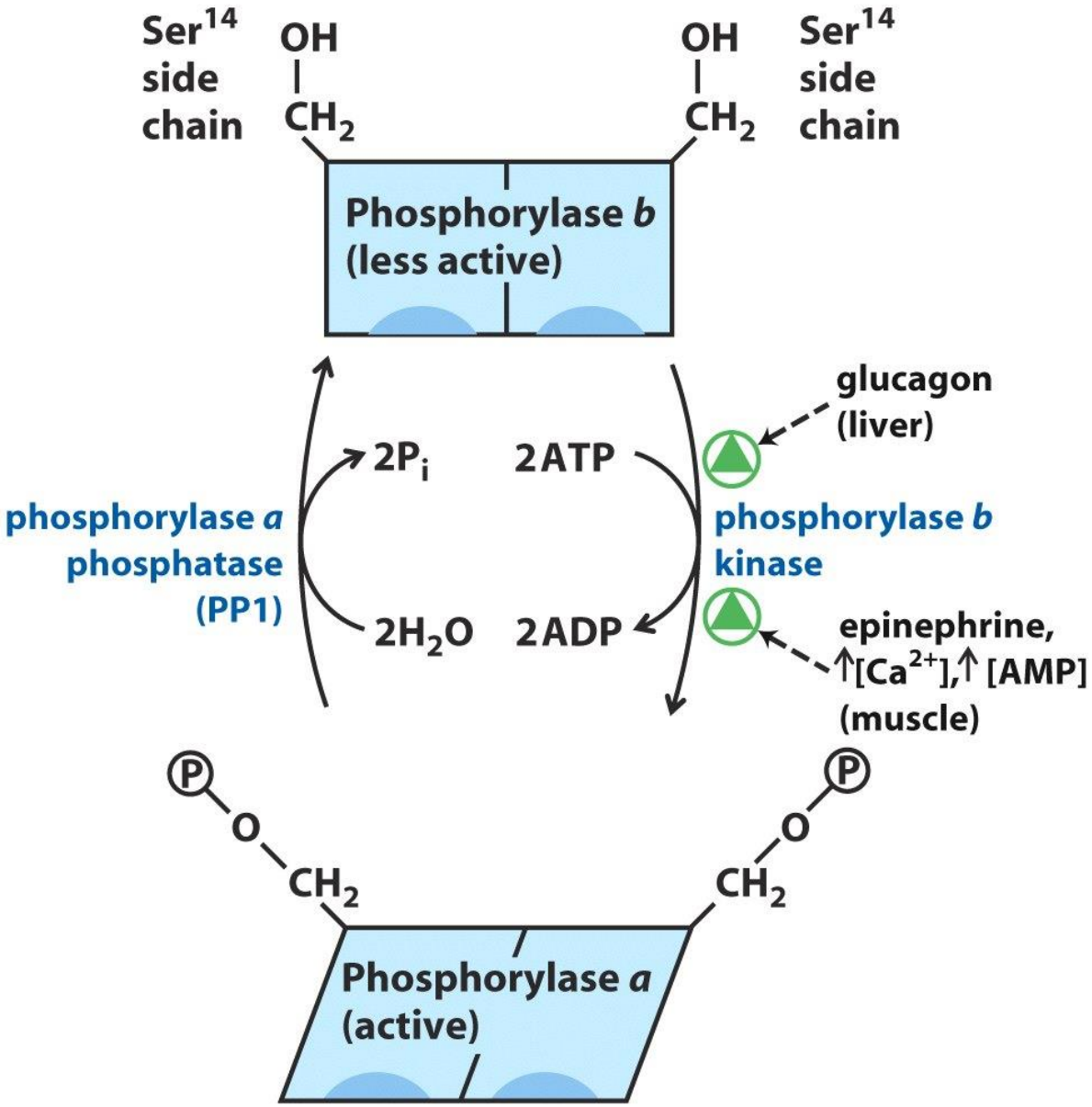
Glycogen synthesis



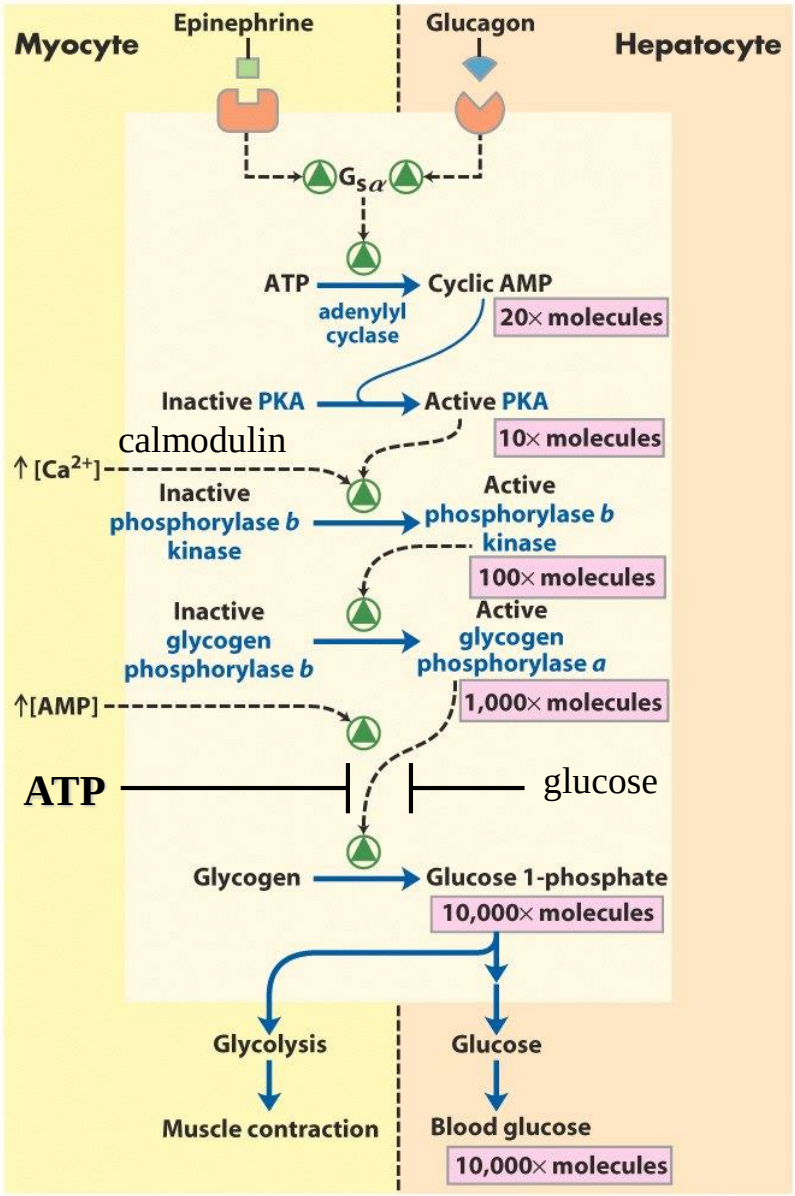
Glycogen synthesis



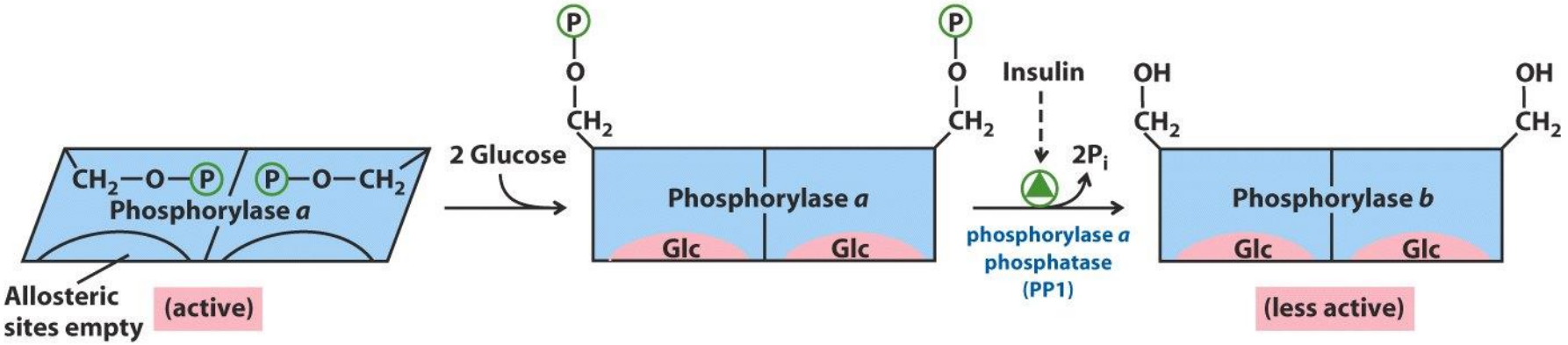
Regulation of muscle glycogen phosphorylase



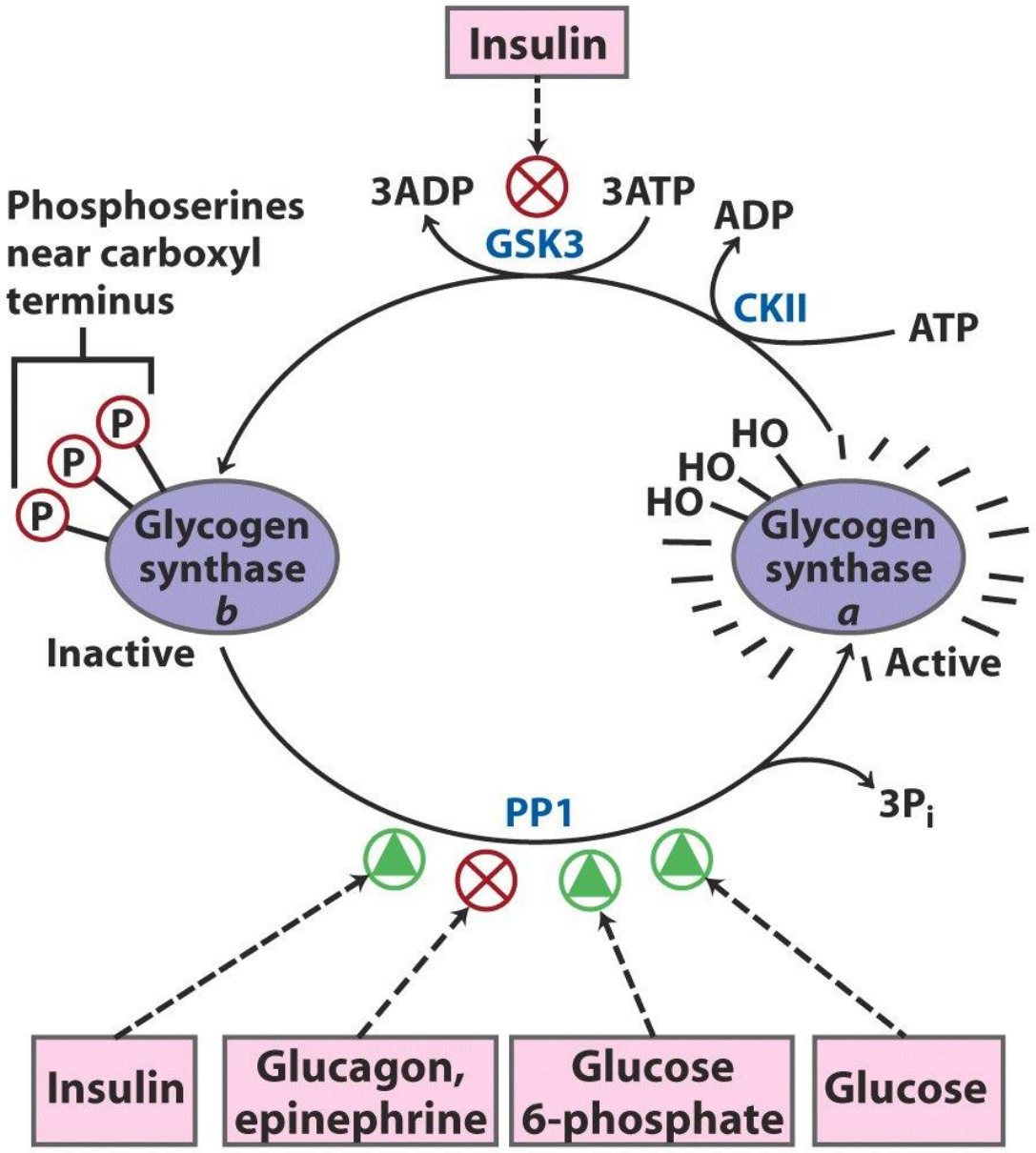
Cascade mechanism of epinephrine and glucagon action



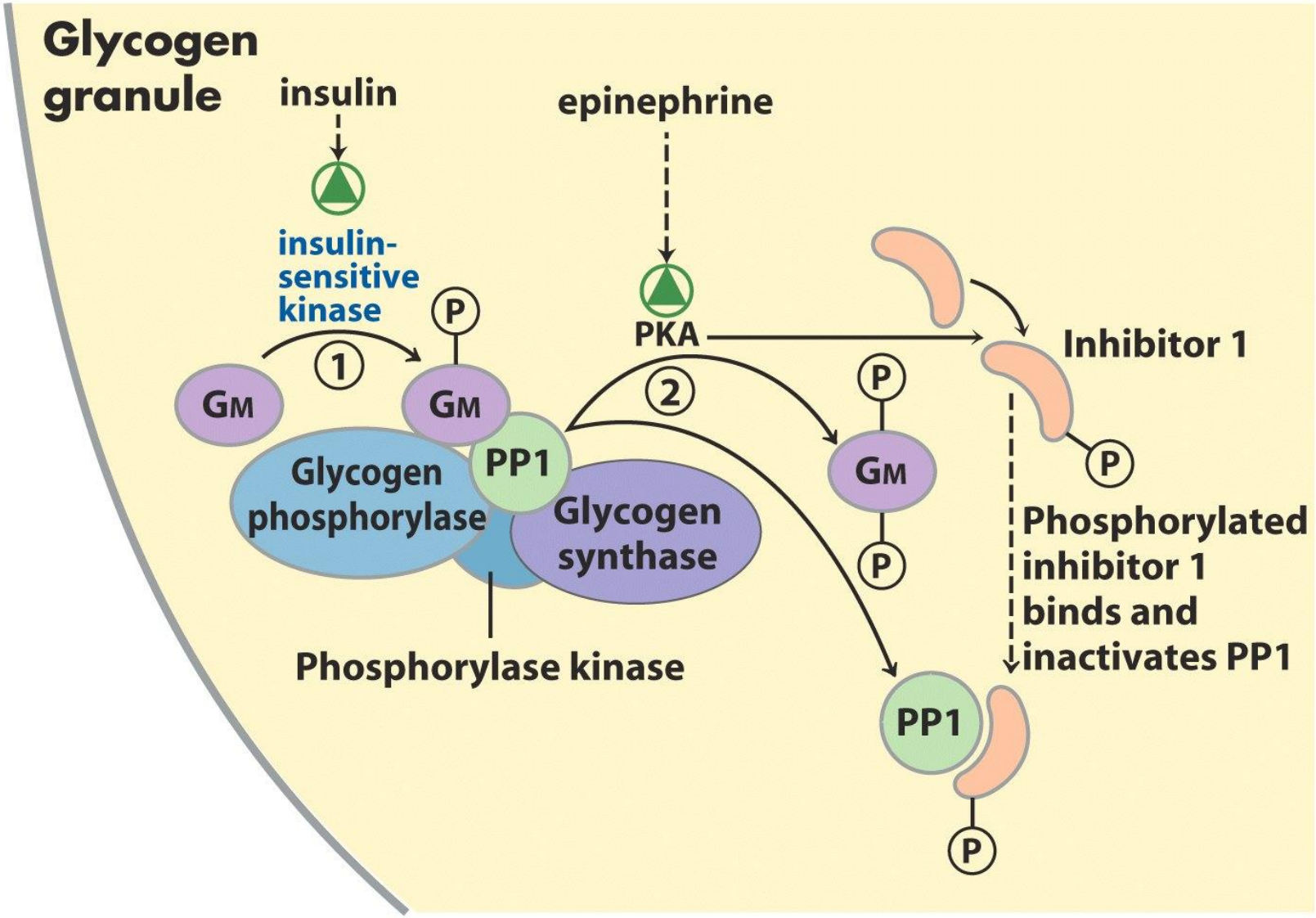
Glycogen phosphorylase of liver as a glucose sensor



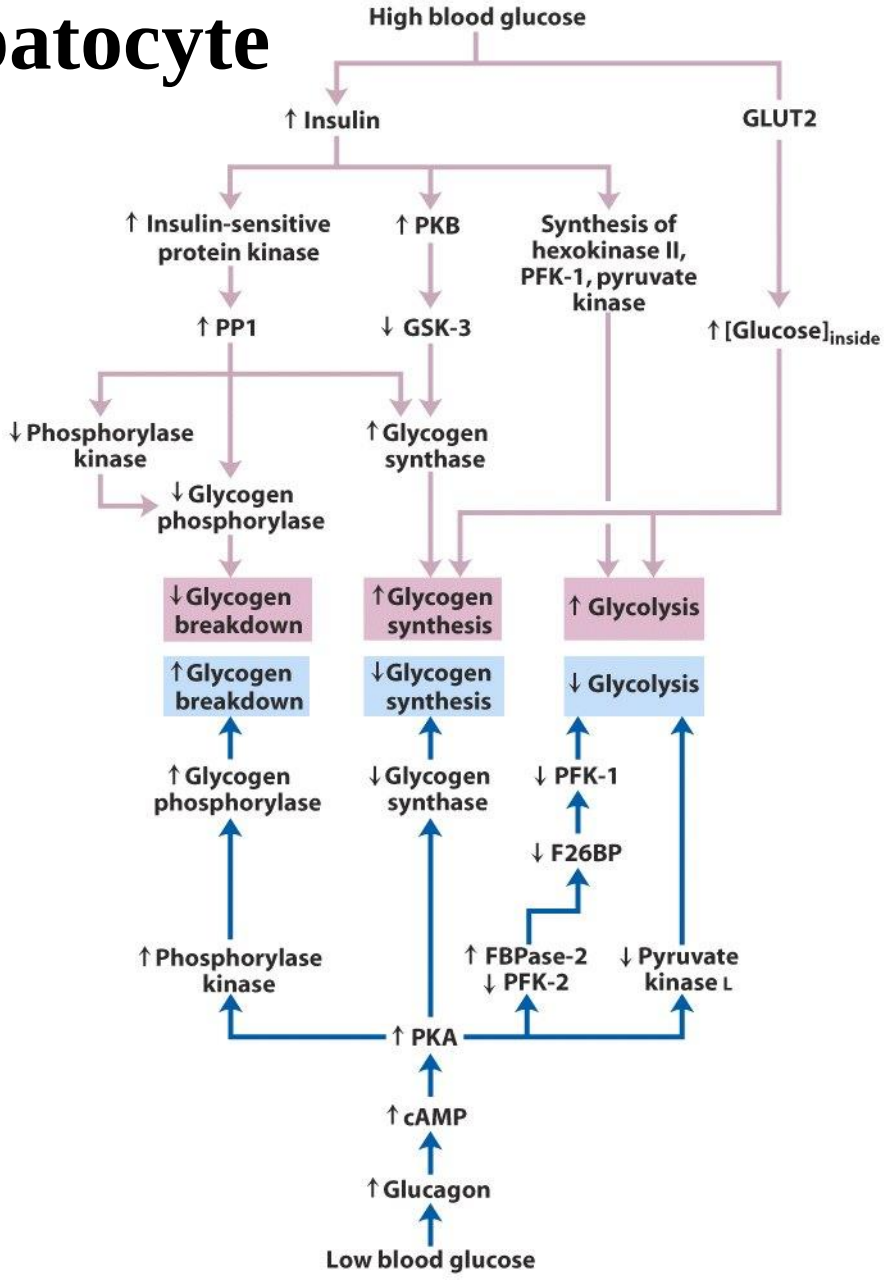
Regulation of glycogen synthase



Glycogen-targeting protein (G_M)



Regulation of carbohydrate metabolism in the hepatocyte

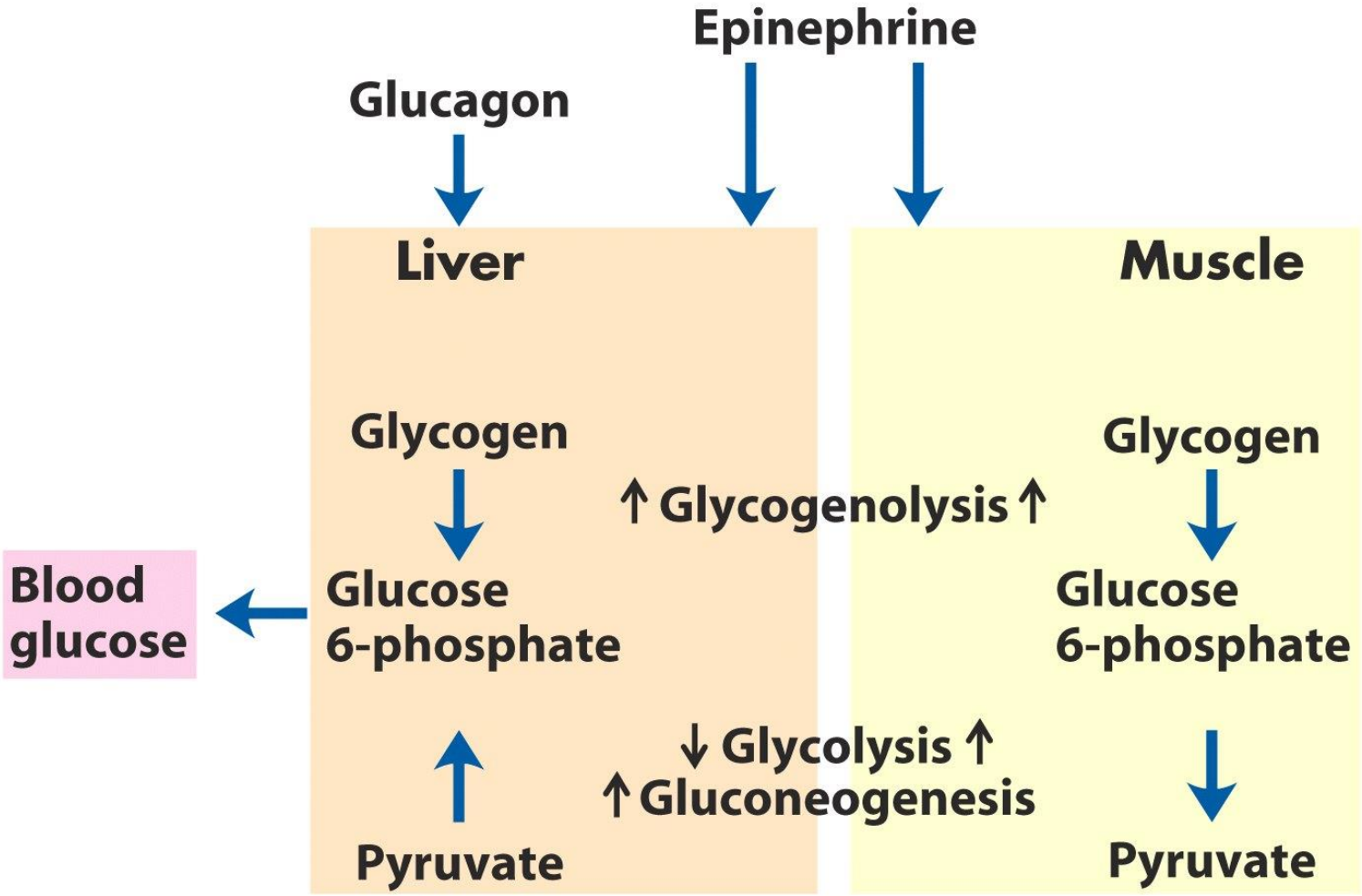


Changes in the expression of some insulin-regulated genes

TABLE 15–3 Some of the Genes Regulated by Insulin

Change in gene expression	*Pathway*
Increased expression	
Hexokinase II	Glycolysis
Hexokinase IV	Glycolysis
Phosphofructokinase-1 (PFK-1)	Glycolysis
Pyruvate kinase	Glycolysis
PFK-2/FBPase-2	Regulation of glycolysis/gluconeogenesis
Glucose 6-phosphate dehydrogenase	Pentose phosphate pathway (NADPH)
6-Phosphogluconate dehydrogenase	Pentose phosphate pathway (NADPH)
Pyruvate dehydrogenase	Fatty acid synthesis
Acetyl-CoA carboxylase	Fatty acid synthesis
Malic enzyme	Fatty acid synthesis (NADPH)
ATP-citrate lyase	Fatty acid synthesis (provides acetyl-CoA)
Fatty acid synthase complex	Fatty acid synthesis
Stearoyl-CoA dehydrogenase	Fatty acid desaturation
Acyl-CoA–glycerol transferases	Triacylglycerol synthesis
Decreased expression	
PEP carboxykinase	Gluconeogenesis
Glucose 6-phosphatase (catalytic subunit)	Glucose release to blood

Regulation of carbohydrate metabolism in liver and muscle



Pentose phosphate pathway

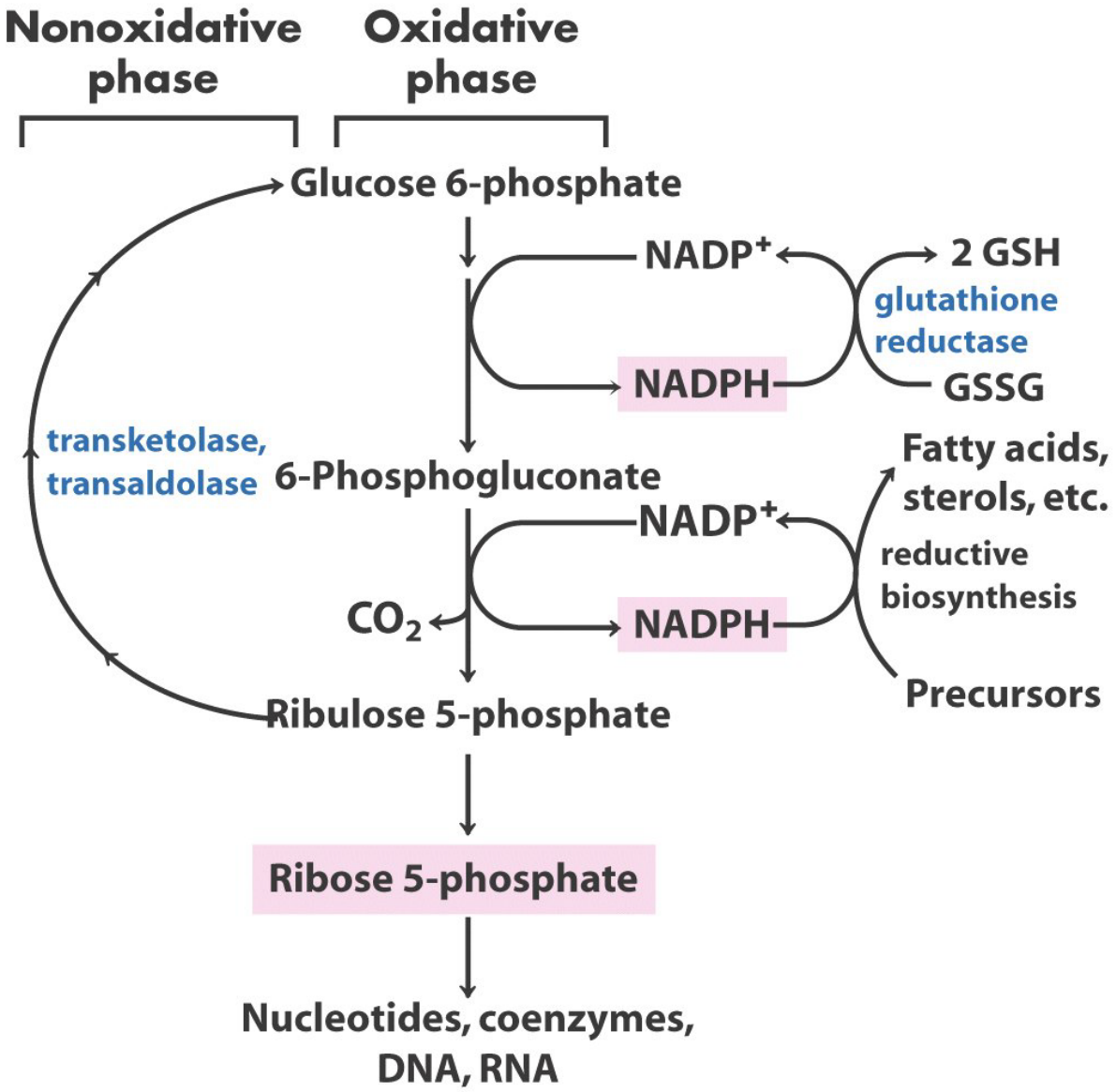


TABLE 20.2 Pathways requiring NADPH

Synthesis

Fatty acid biosynthesis

Cholesterol biosynthesis

Neurotransmitter biosynthesis

Nucleotide biosynthesis

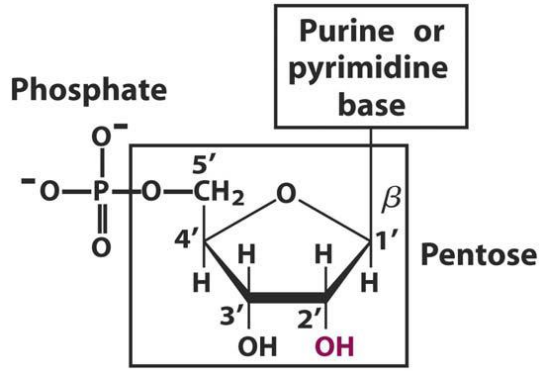
Detoxification

Reduction of oxidized glutathione

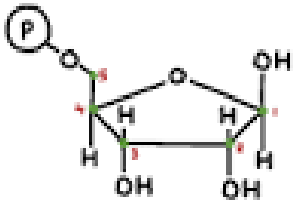
Cytochrome P450 monooxygenases

Fate of Pentoses

(bone marrow, skin, intestinal mucosa)

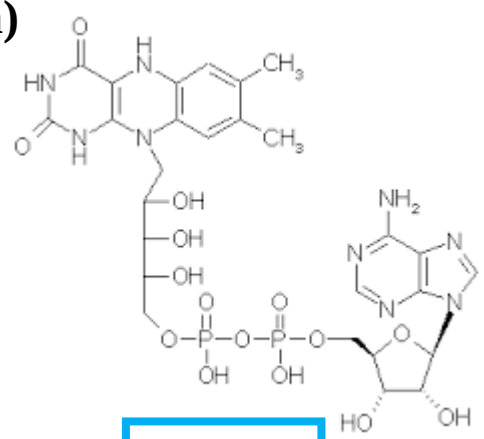


Nucleotides (DNA, RNA)

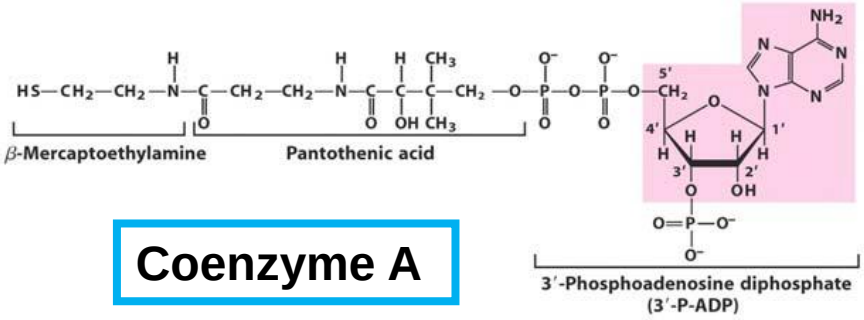


R-5-P

ribose-5-phosphate



$FADH_2$



Coenzyme A

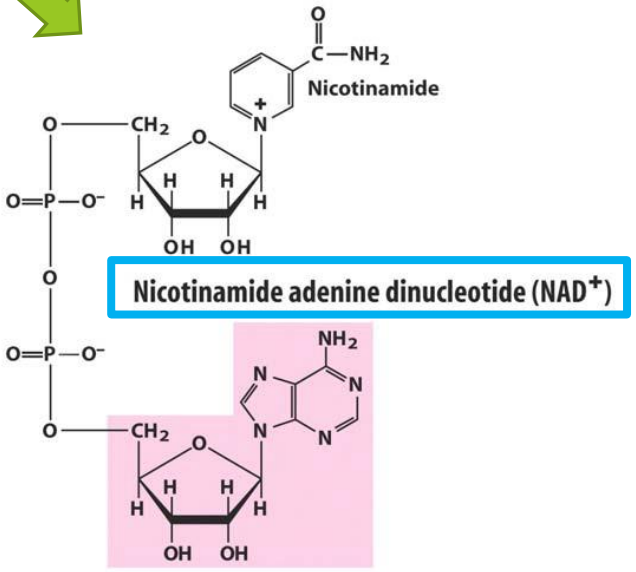
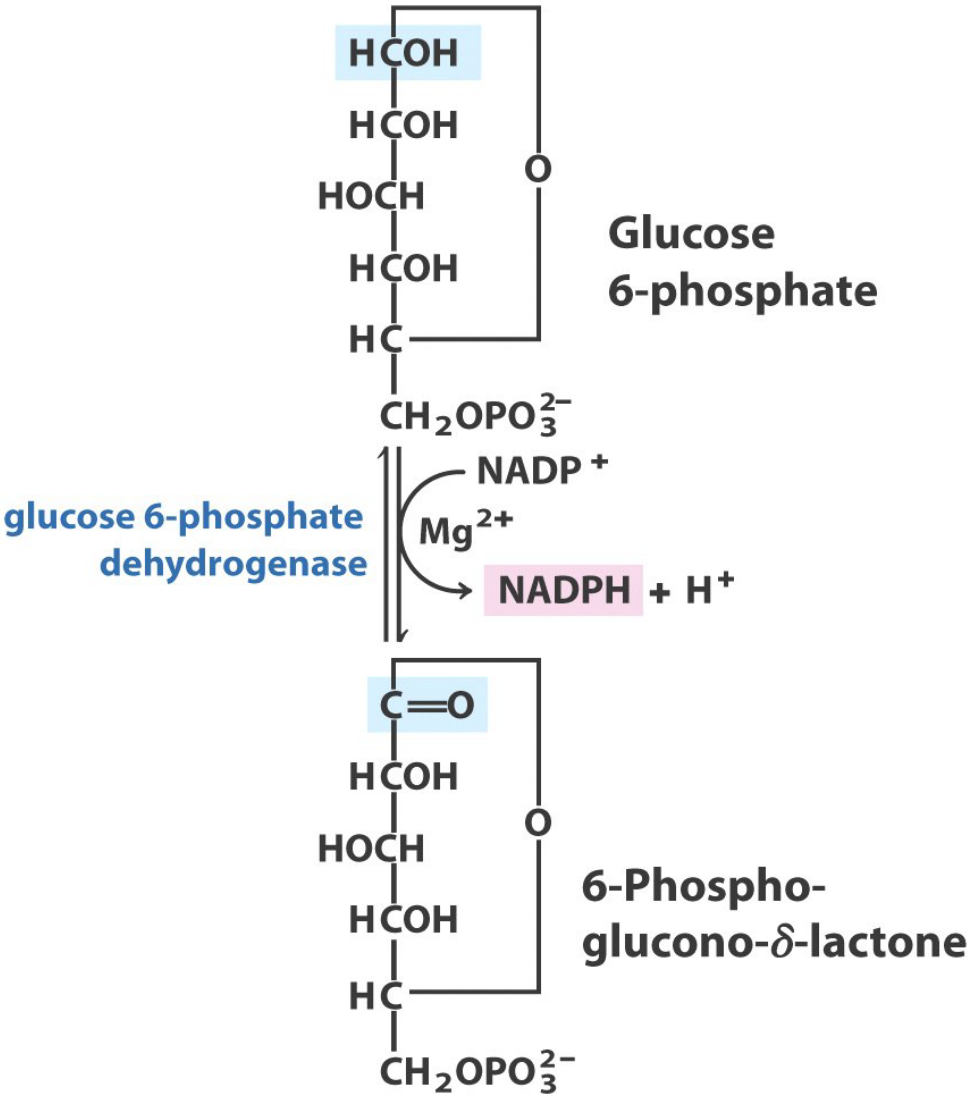


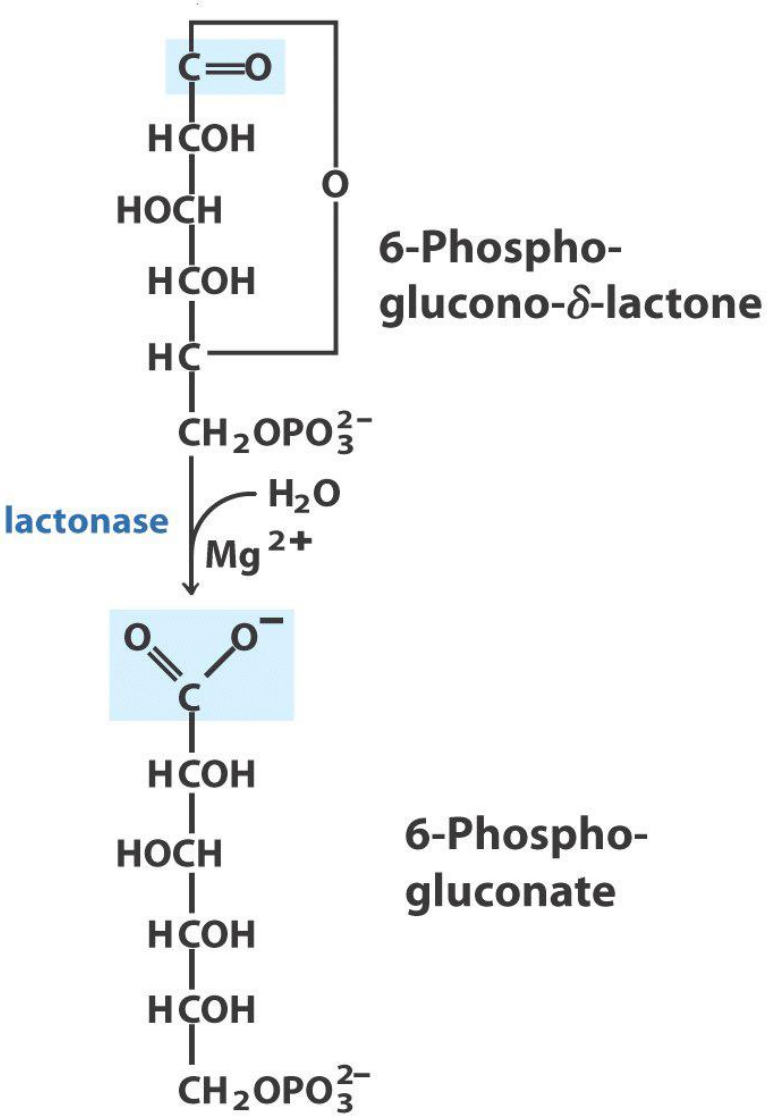
TABLE 20.4 Tissues with active pentose phosphate pathways

Tissue	Function
Adrenal gland	Steroid synthesis
Liver	Fatty acid and cholesterol synthesis
Testes	Steroid synthesis
Adipose tissue	Fatty acid synthesis
Ovary	Steroid synthesis
Mammary gland	Fatty acid synthesis
Red blood cells	Maintenance of reduced glutathione

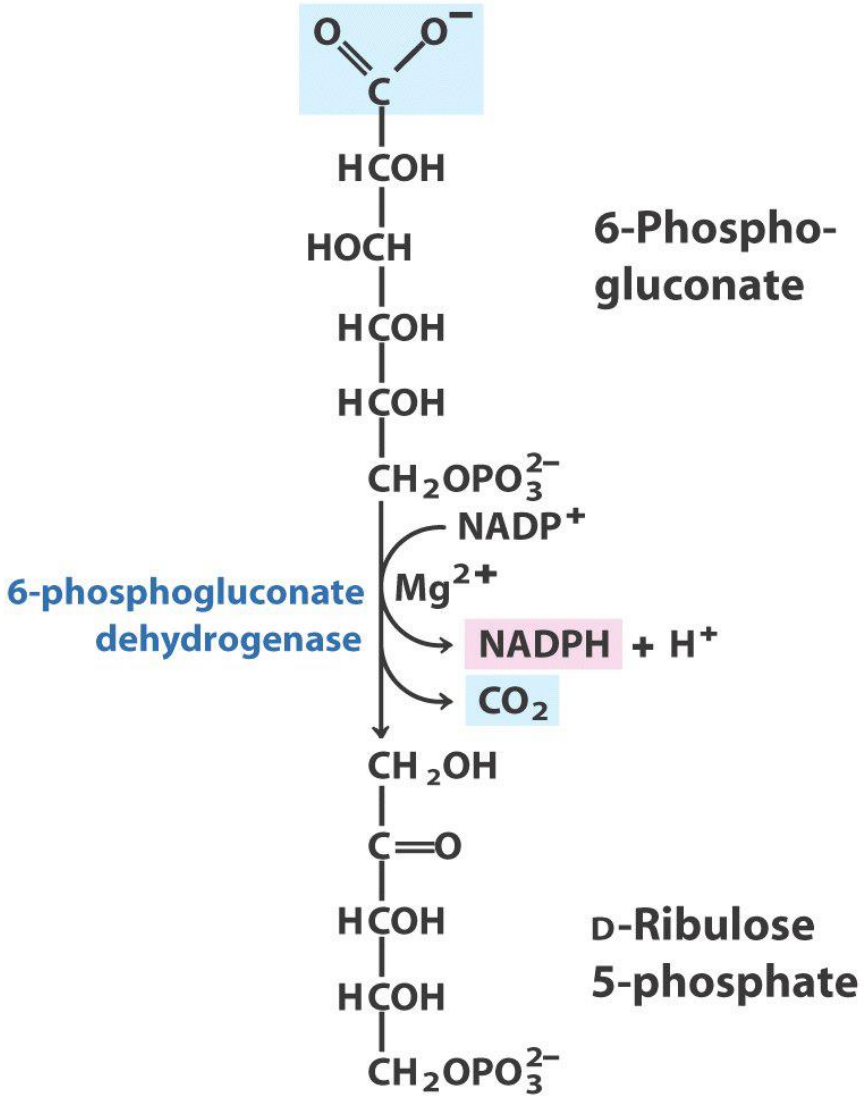
Reactions of the pentose phosphate pathway



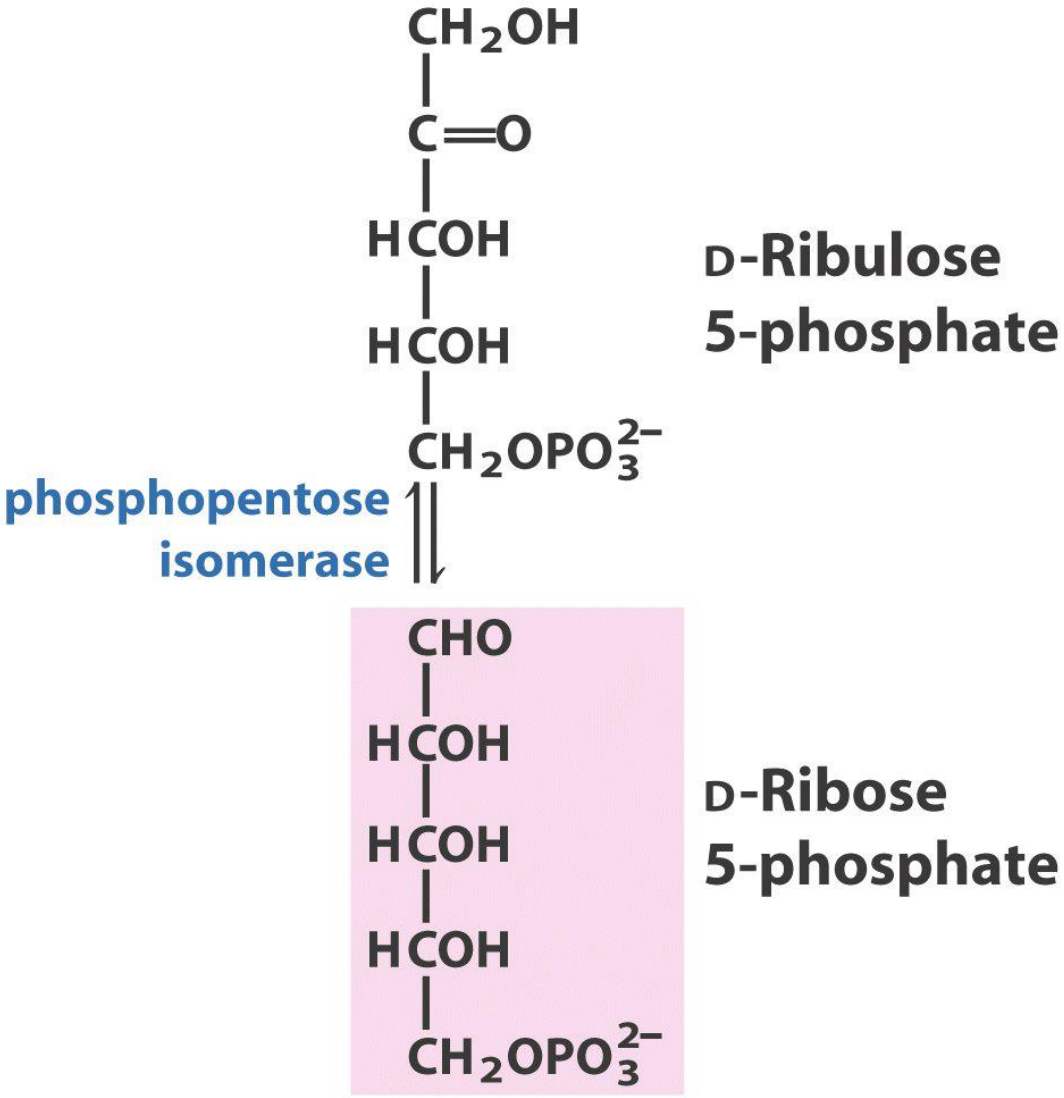
Reactions of the pentose phosphate pathway



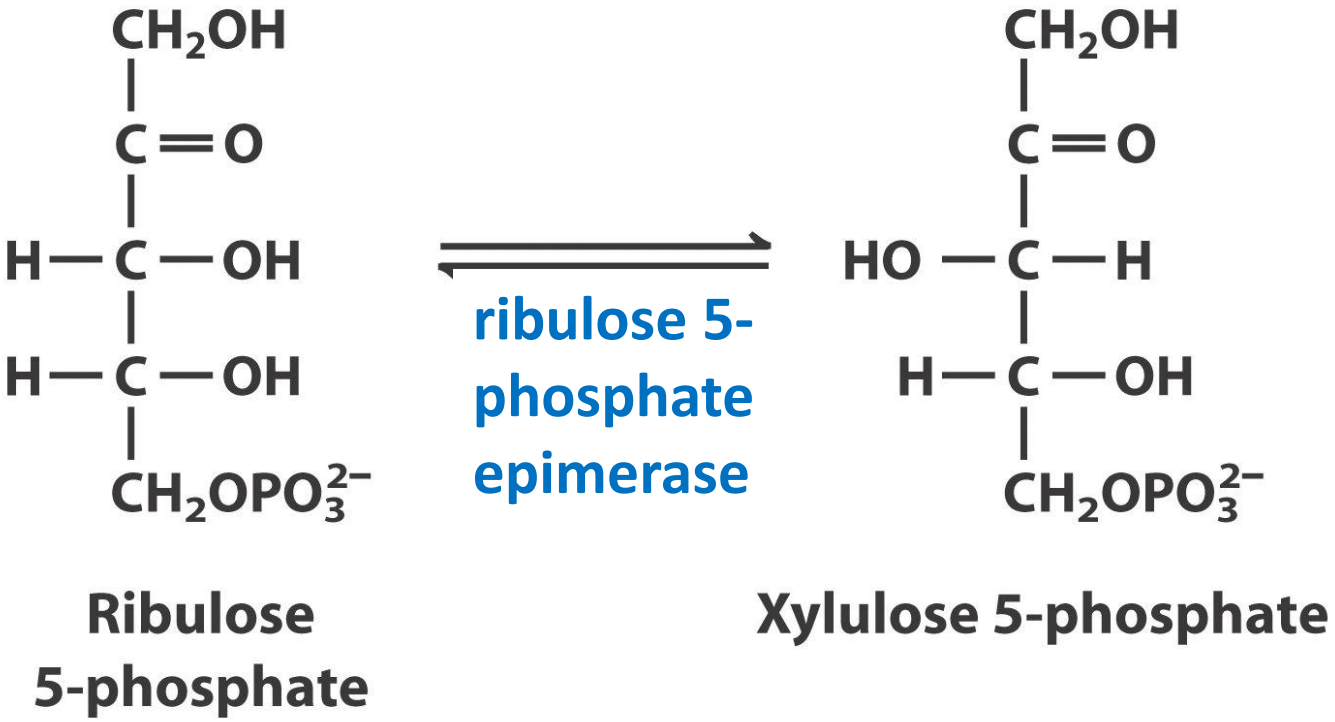
Reactions of the pentose phosphate pathway



Reactions of the pentose phosphate pathway



Reactions of the pentose phosphate pathway



Reactions of the pentose phosphate pathway

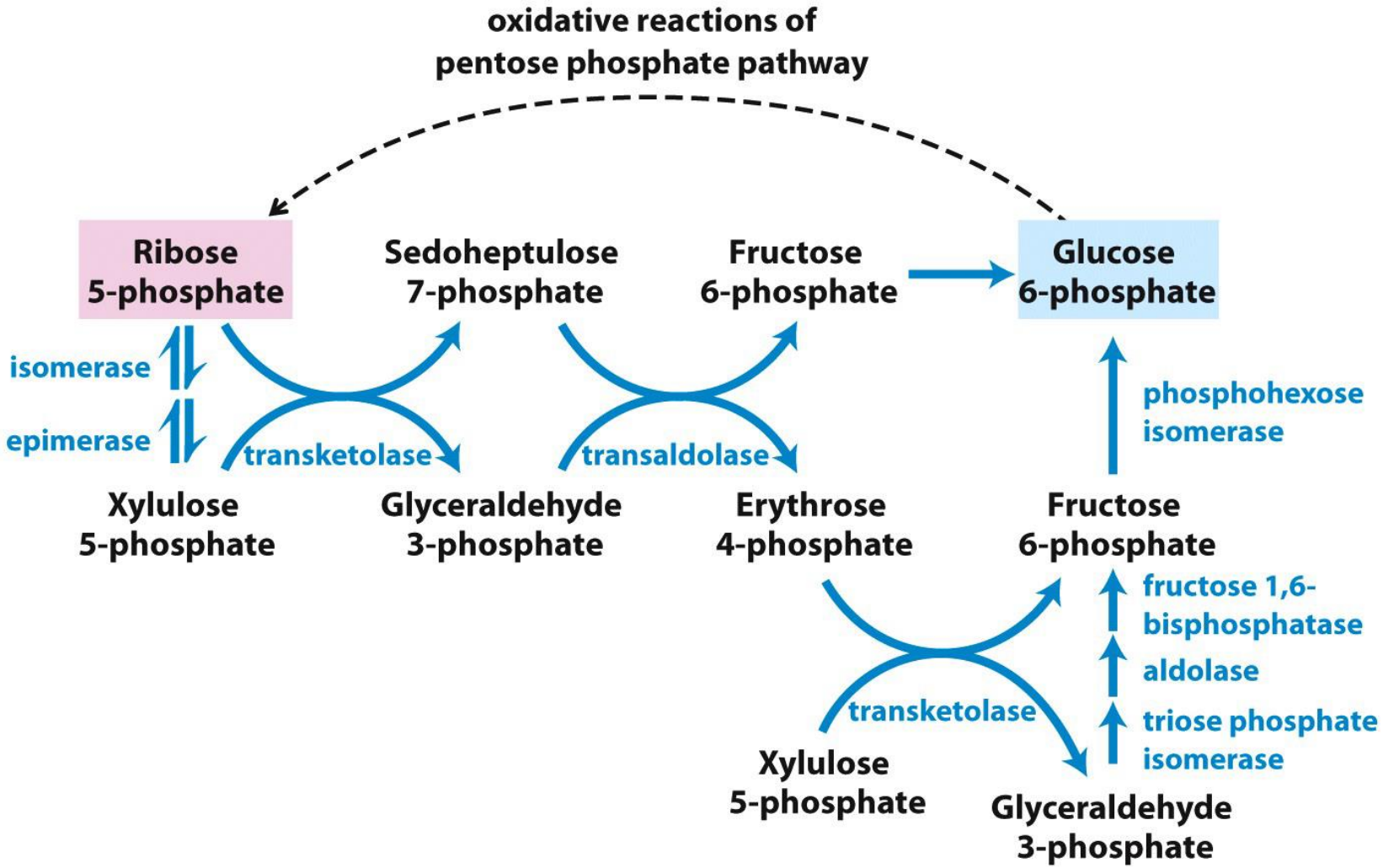


Figure 14-22a
Lehninger Principles of Biochemistry, Fifth Edition

Reactions of the pentose phosphate pathway

Figure 14-24a
Lehninger Principles of Biochemistry, Seventh Edition

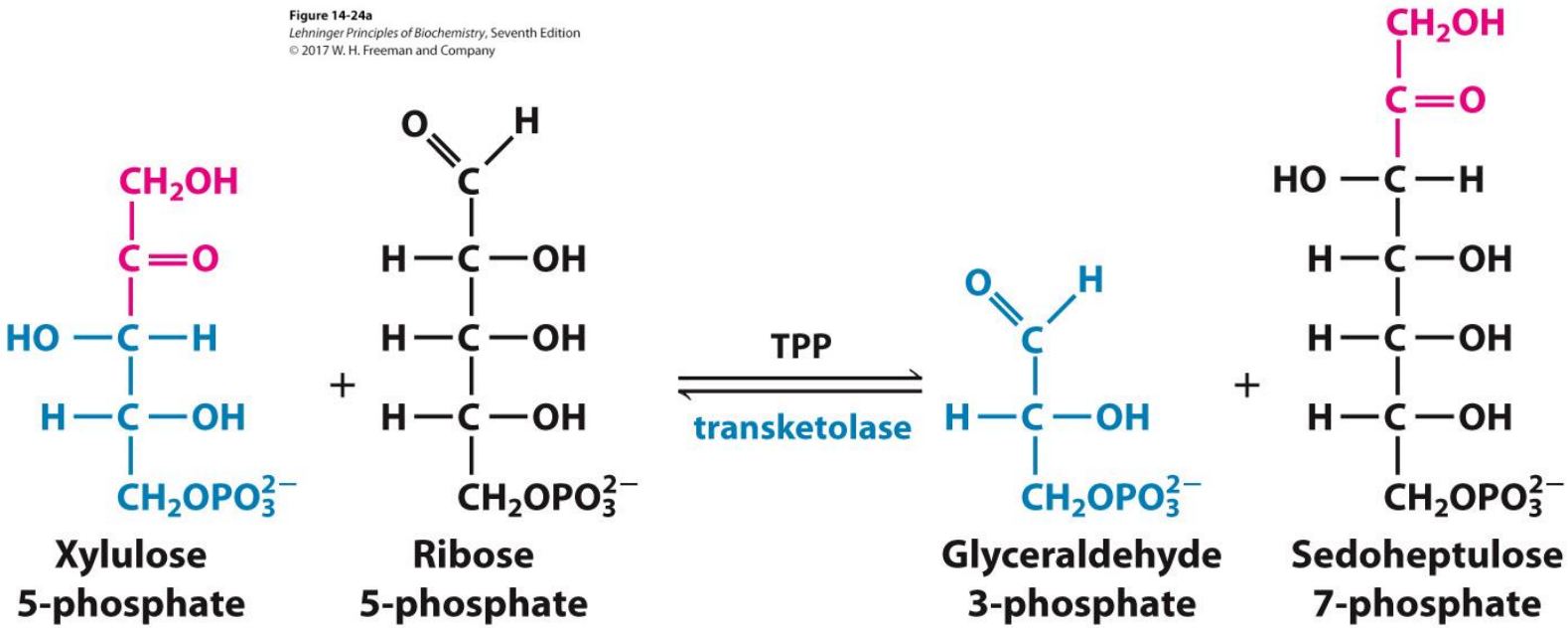


Figure 14-24b
Lehninger Principles of Biochemistry, Seventh Edition

Reactions of the pentose phosphate pathway

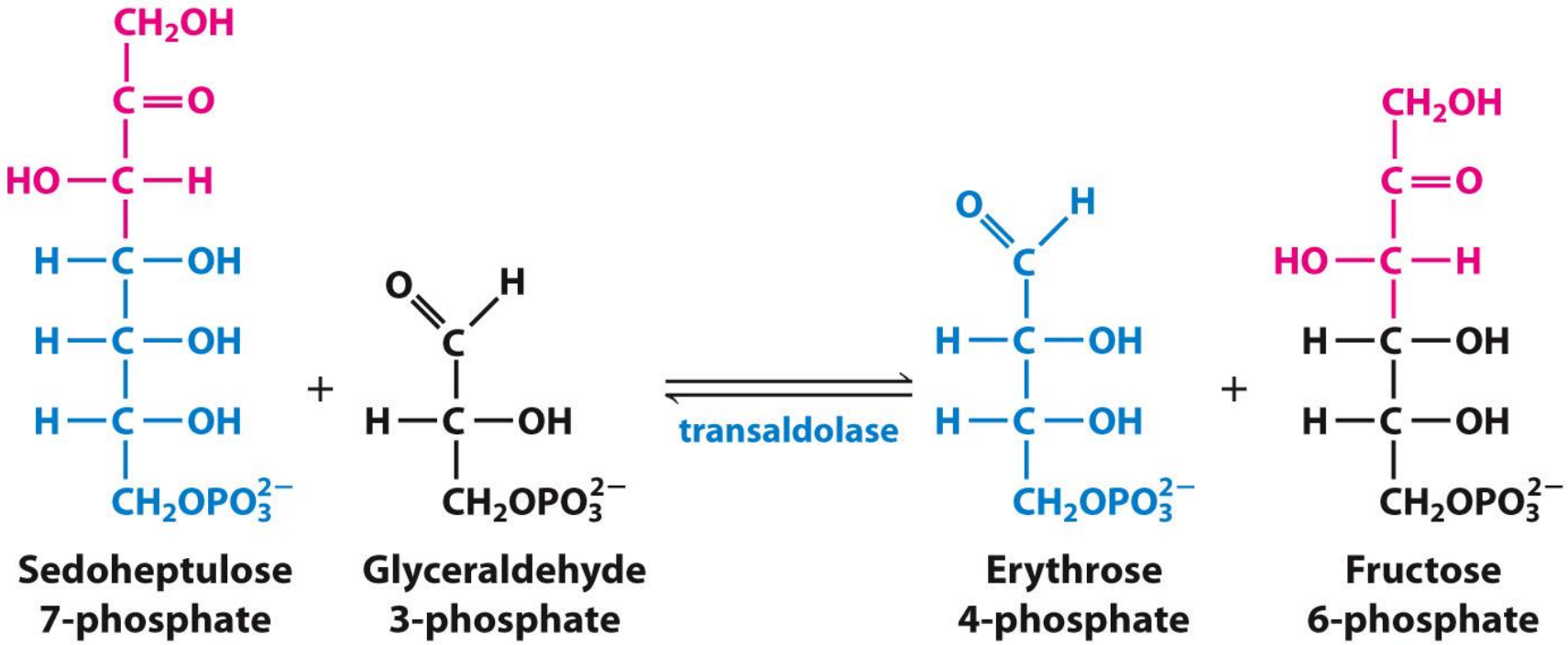
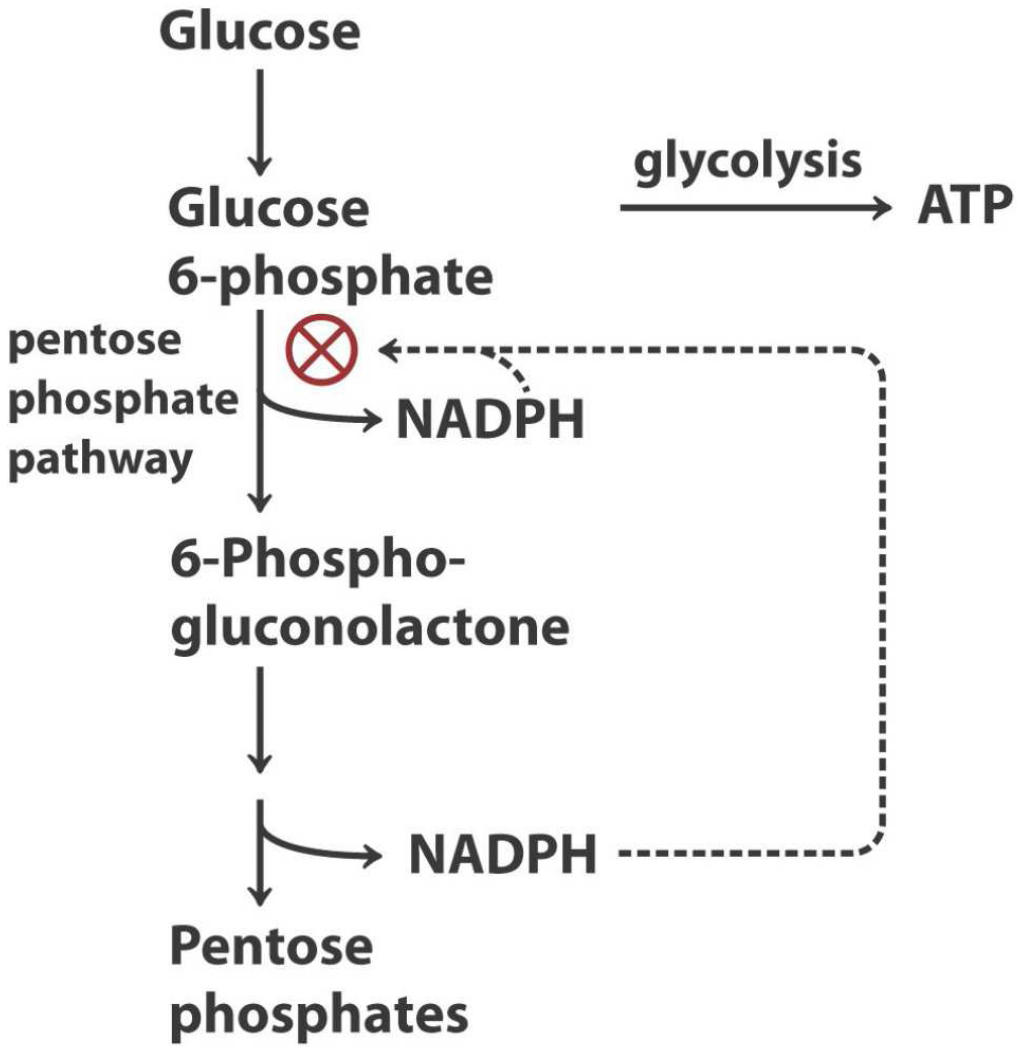
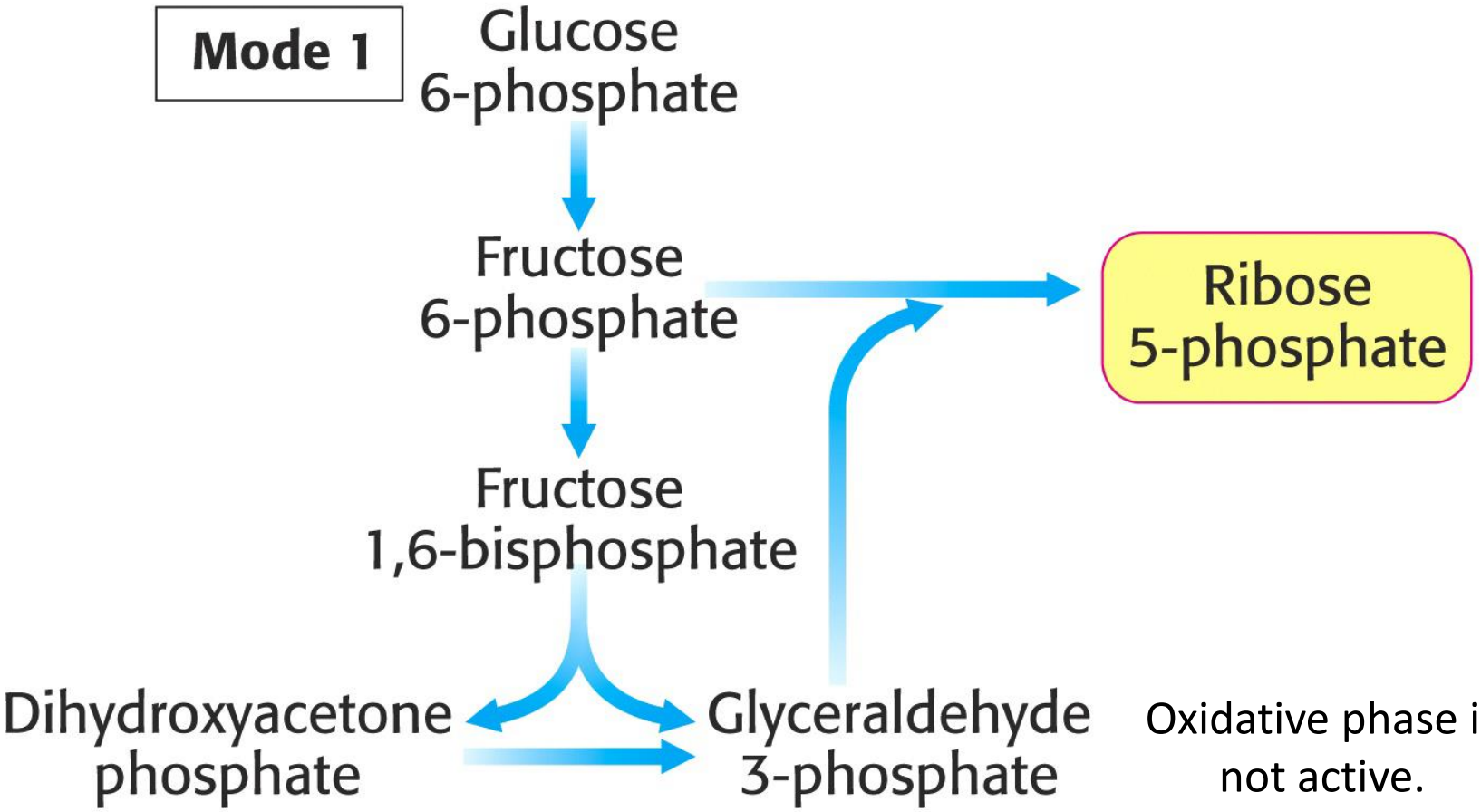


Figure 14-25
Lehninger Principles of Biochemistry, Seventh Edition

Regulation of penthose phosphate pathway

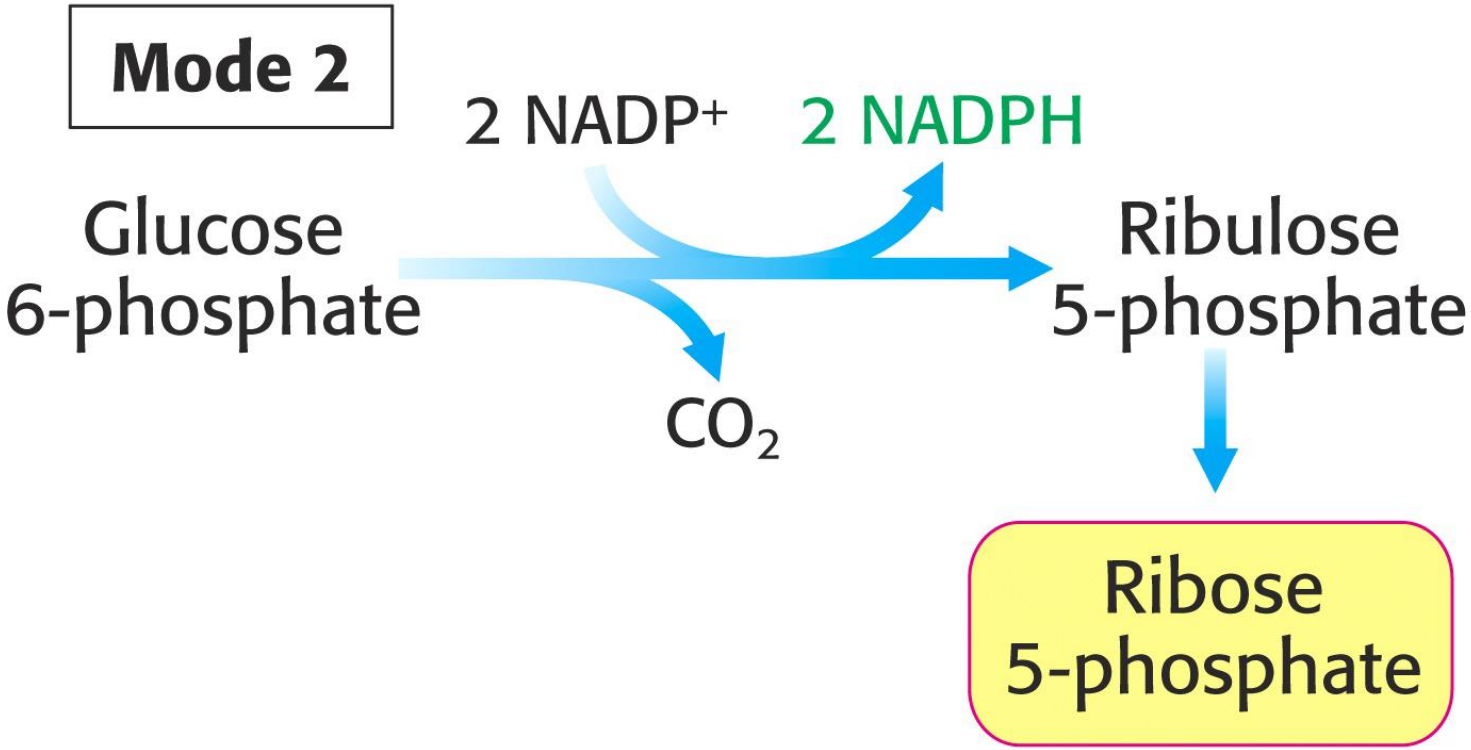


Four possible fates of G-6-P
I. Ribose 5-phosphate is needed



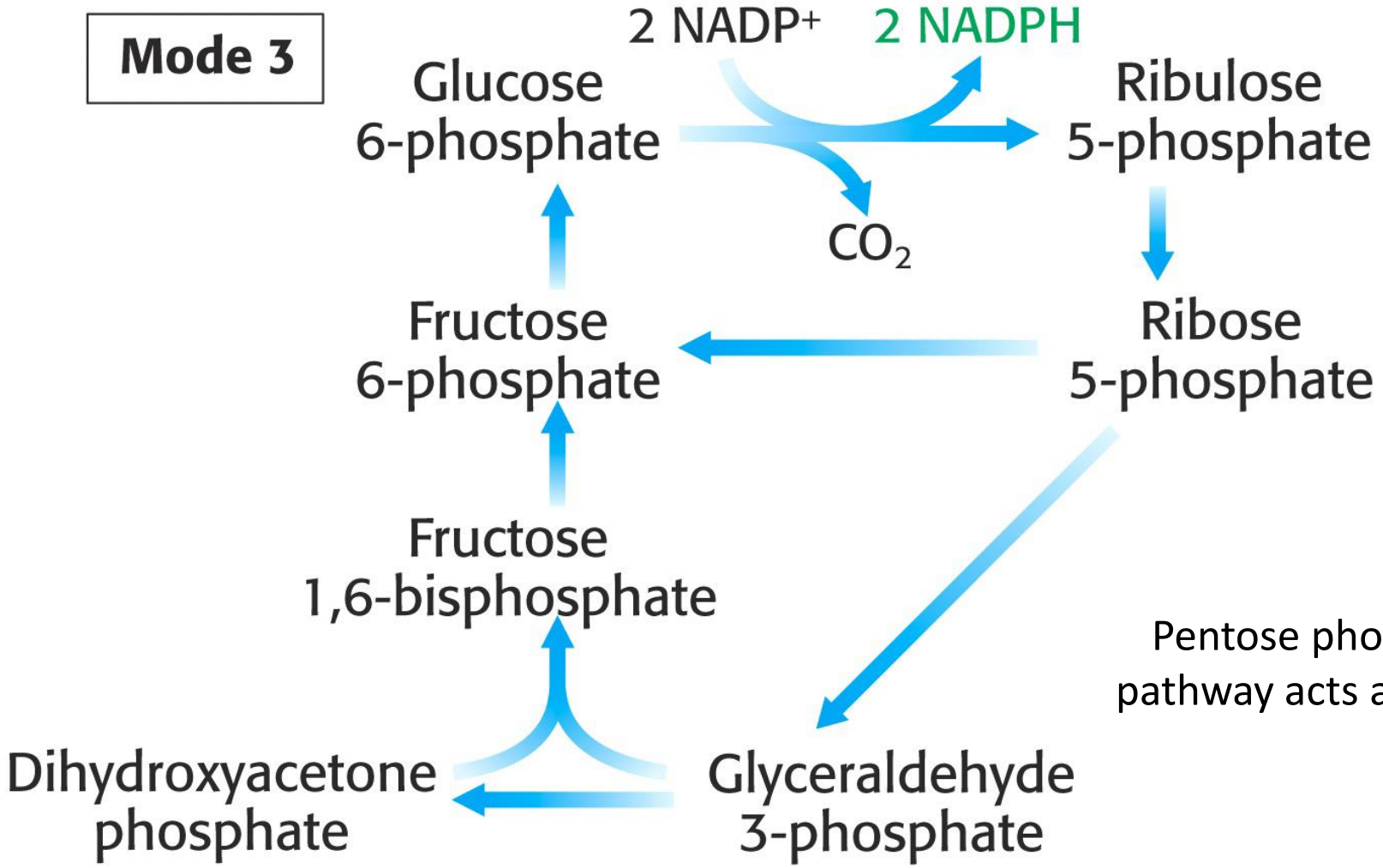
Oxidative phase is not active.

Four possible fates of G-6-P
II. Ribose5-phosphate and NADPH are needed



Only the oxidative phase is active

Four possible fates of G-6-P
III. NADPH is needed



Pentose phosphate pathway acts as a cycle

Four possible fates of G-6-P
IV. NADPH and ATP are needed

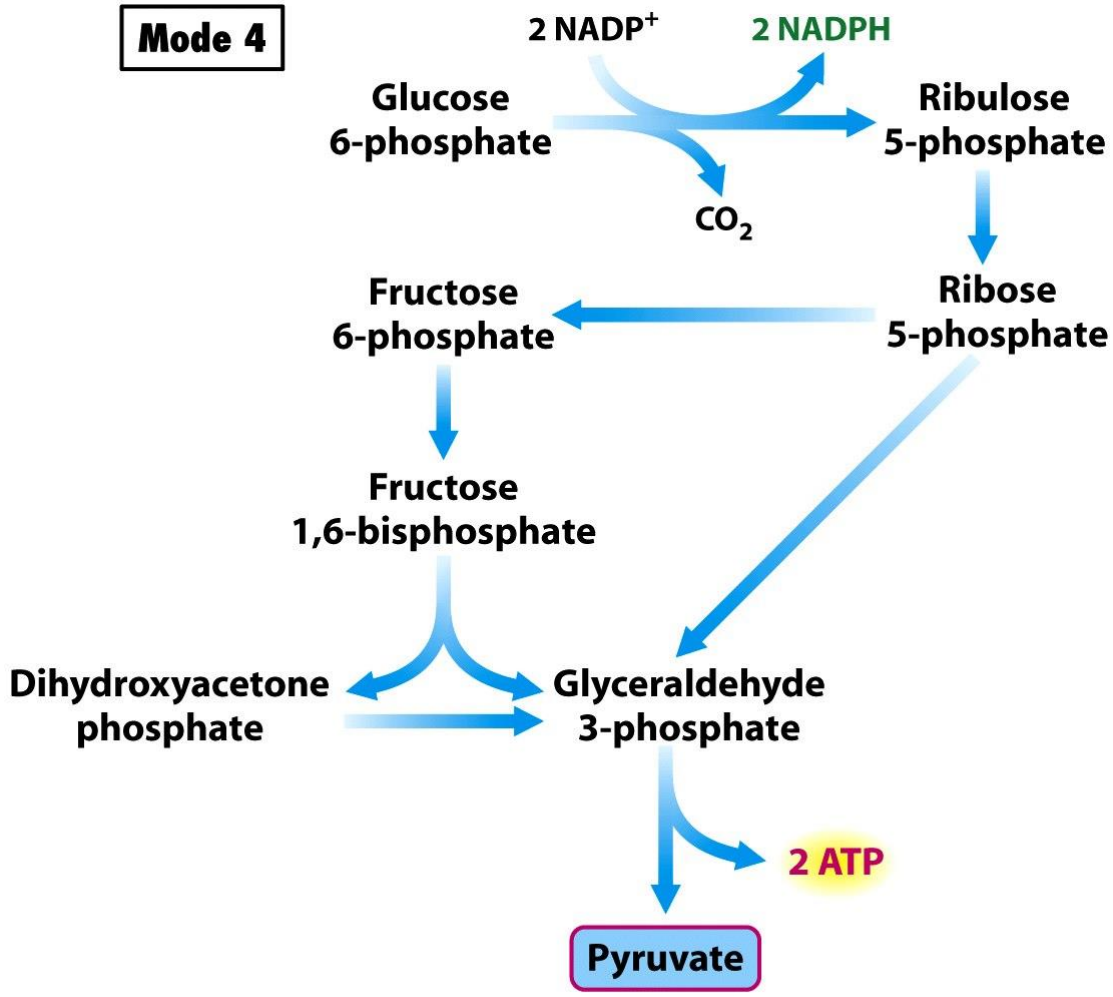


Figure 20-24 part 4
Biochemistry, Sixth Edition

Both phases work simultaneously.

Role of NADPH and glutathione in protecting cells against ROS