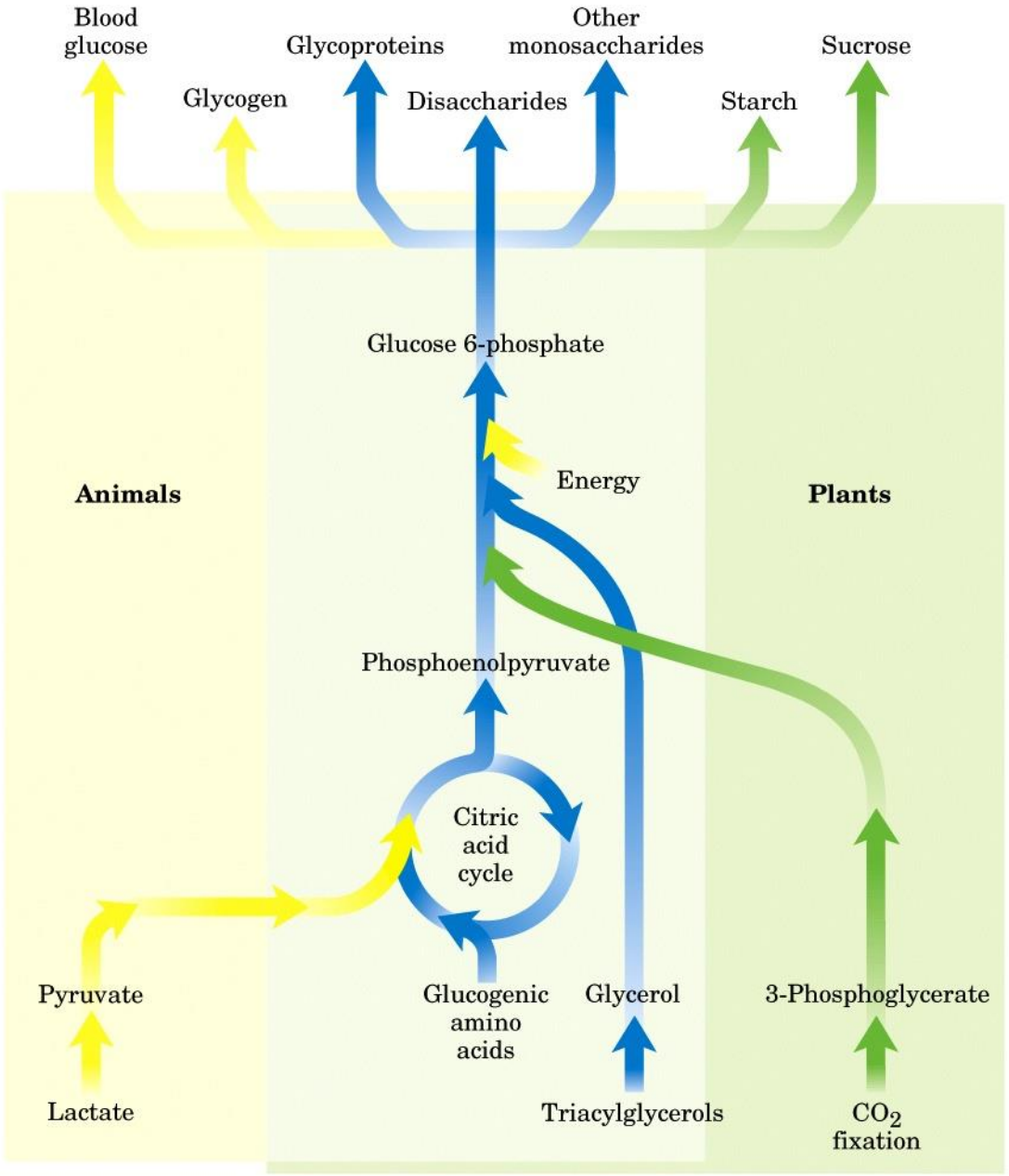
BLOQUE III:
TEMA 14.

ANABOLISMO DE GLÚCIDOS

ÍNDICE

Síntesis de glúcidos a partir de precursores sencillos



Los ácidos grasos no son precursores de la gluconeogénesis

GLUCONEOGÉNESIS

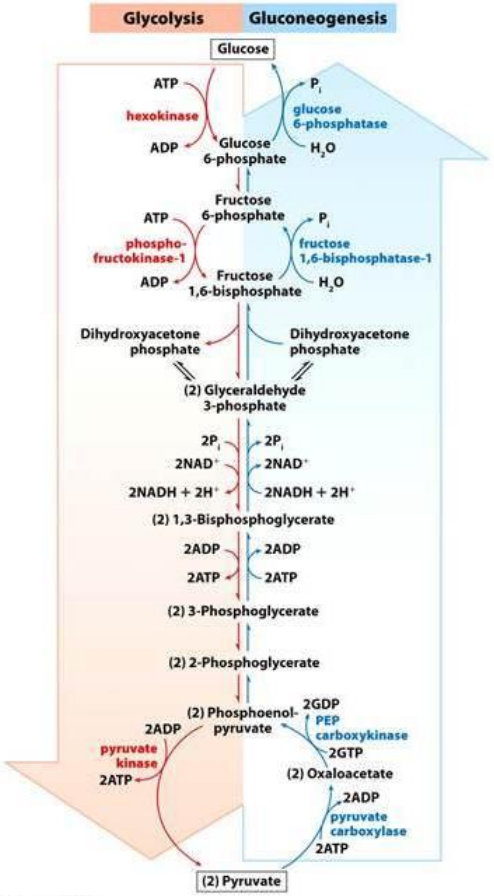


Figure 14-17
Lehninger Principles of Biochemistry, Sixth Edition
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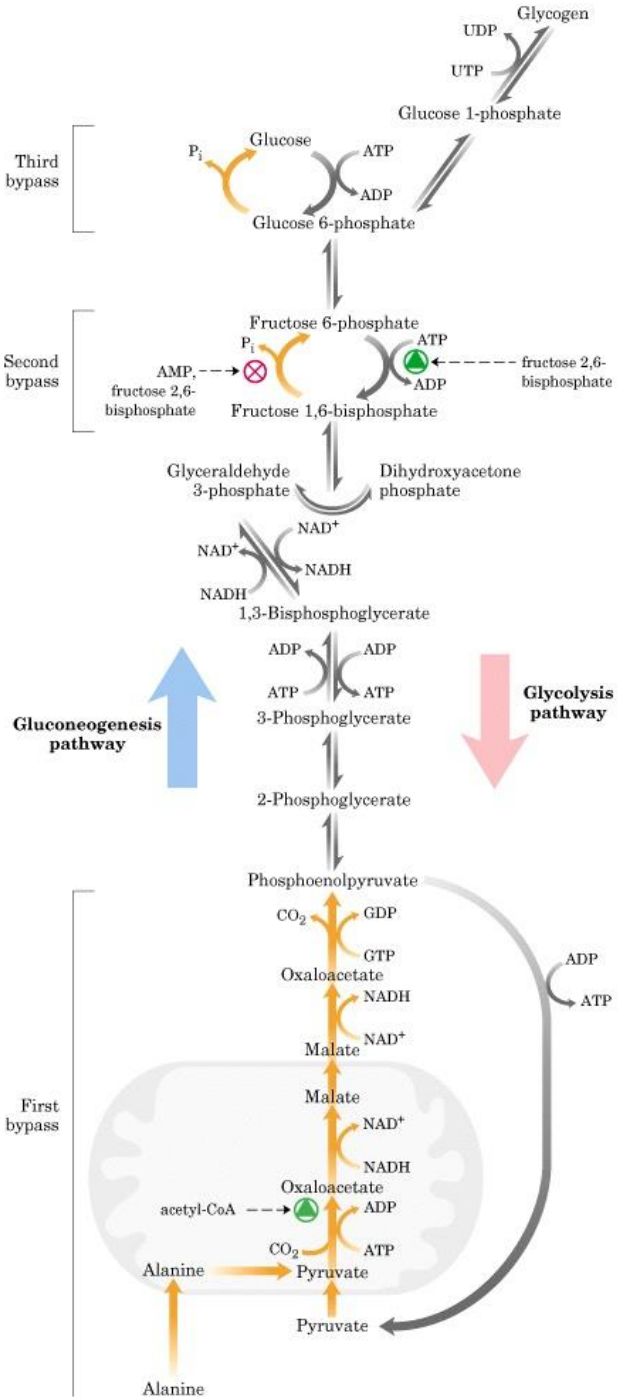
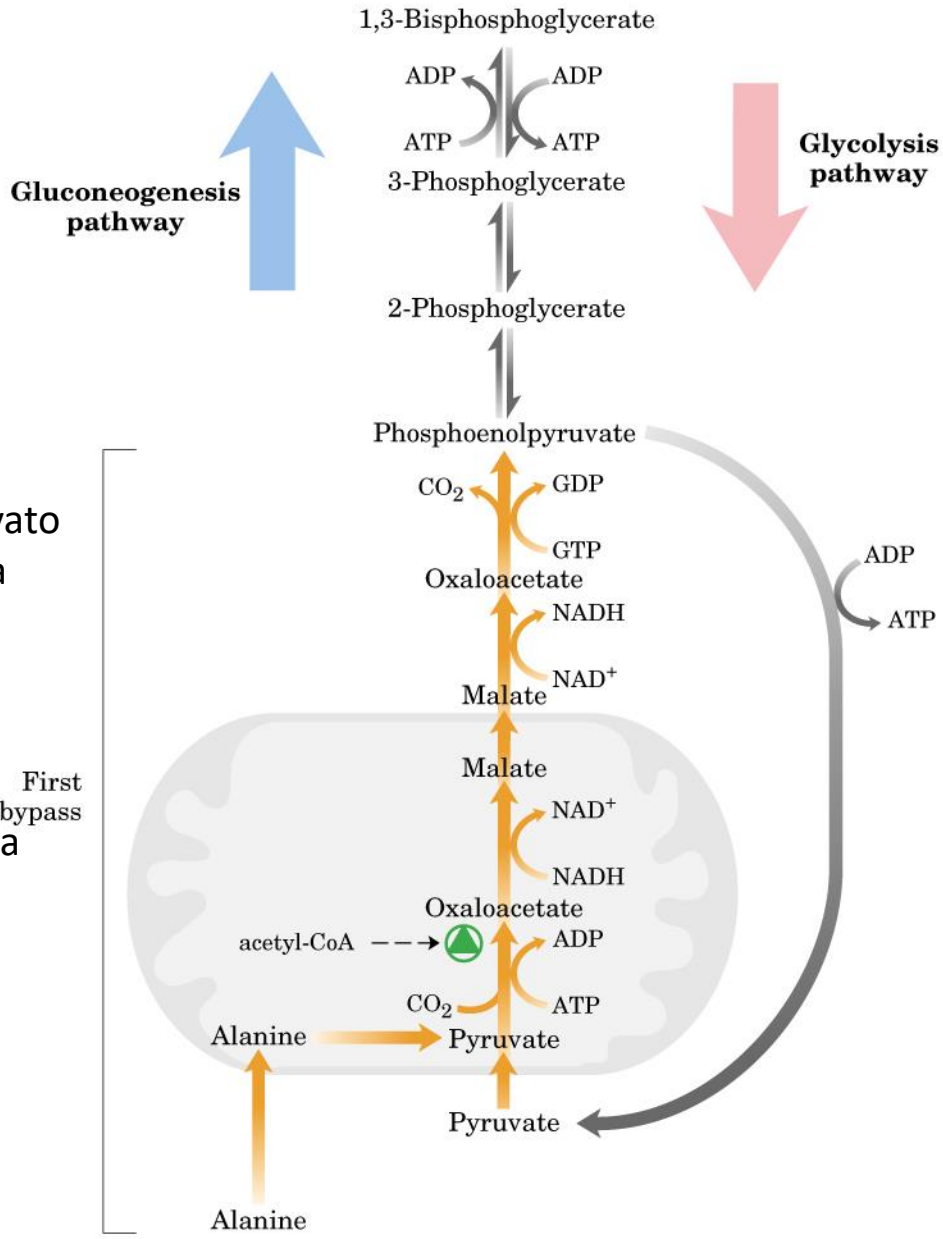


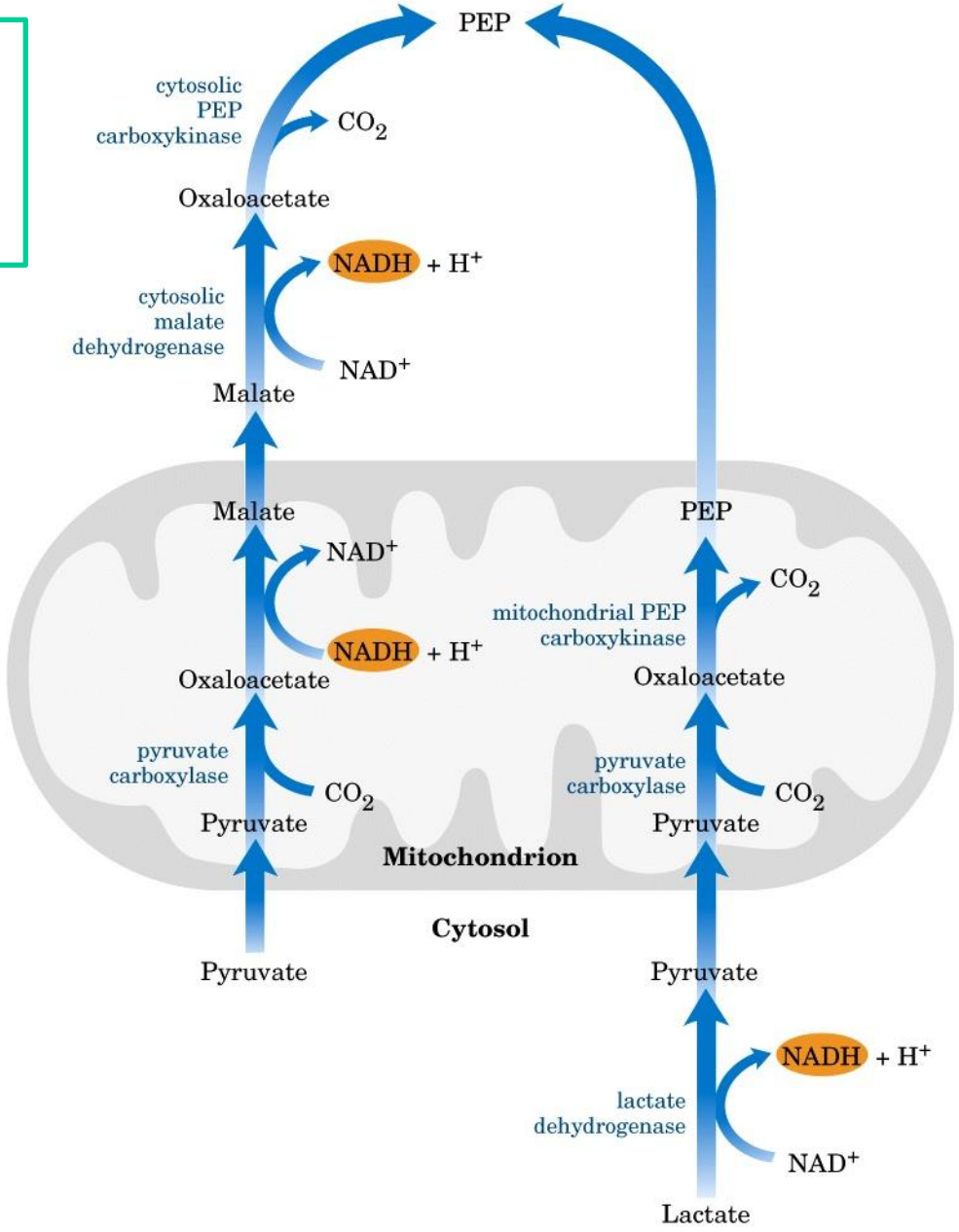
Fosfoenolpiruvato carboxiquinasa

Malato deshidrogenasa

Piruvato carboxilasa



Rutas alternativas desde el piruvato al fosfoenolpiruvato



Glucosa -6-fosfatasa

Fructosa 1,6 bifosfatasa

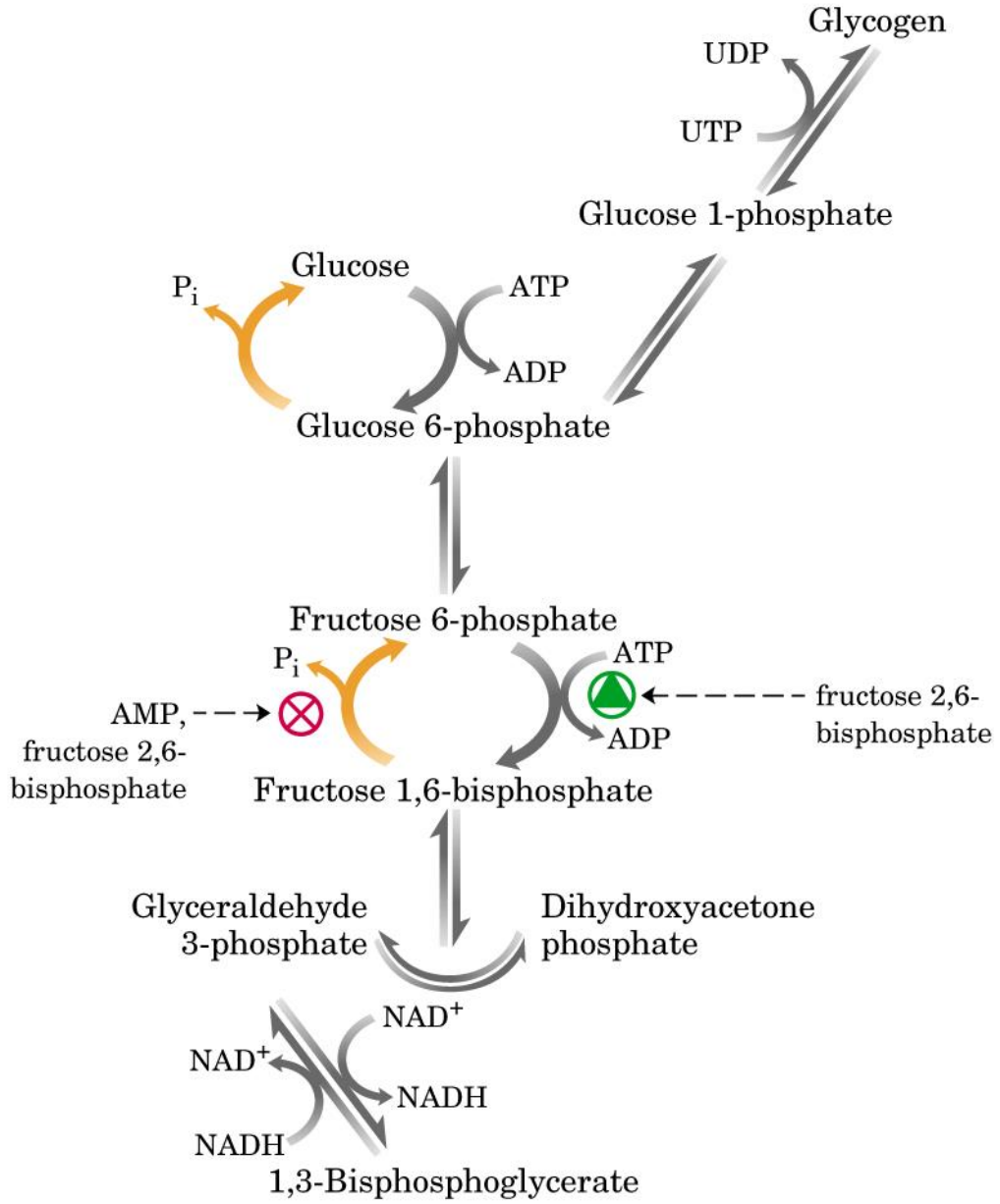


table 20–1

Free-Energy Changes of Glycolytic Reactions in Erythrocytes*

Glycolytic reaction step	$\Delta G'°$ (kJ/mol)	ΔG (kJ/mol)
① Glucose + ATP ⟶ glucose 6-phosphate + ADP + H^+	−16.7	−33.4
② Glucose 6-phosphate ⇌ fructose 6-phosphate	1.7	−2.5
③ Fructose 6-phosphate + ATP ⟶ fructose 1,6-bisphosphate + ADP + H^+	−14.2	−22.2
④ Fructose 1,6-bisphosphate ⇌ dihydroxyacetone phosphate + glyceraldehyde 3-phosphate	23.8	−1.25
⑤ Dihydroxyacetone phosphate ⇌ glyceraldehyde 3-phosphate	7.5	2.5
⑥ Glyceraldehyde 3-phosphate + P_i + NAD^+ ⇌ 1,3-bisphosphoglycerate + NADH + H^+	6.3	−1.7
⑦ 1,3-Bisphosphoglycerate + ADP ⇌ 3-phosphoglycerate + ATP	−18.8	1.25
⑧ 3-Phosphoglycerate ⇌ 2-phosphoglycerate	4.4	0.8
⑨ 2-Phosphoglycerate ⇌ phosphoenolpyruvate + H_2O	7.5	−3.3
⑩ Phosphoenolpyruvate + ADP + H^+ ⟶ pyruvate + ATP	−31.4	−16.7

*$\Delta G'°$ is the standard free-energy change, as defined in Chapter 14 (see p. 494). At pH 7.0, ΔG is the free-energy change calculated from the actual concentrations of glycolytic intermediates present under physiological conditions in erythrocytes. The glycolytic reactions bypassed in gluconeogenesis are shown in red.

$$\text{Glucosa} + 2\text{ADP} + 2P_i + 2\text{NAD}^+ \longrightarrow 2\text{Piruvato} + 2\text{ATP} + 2\text{NADH} + 4H^+ + 2H_2O$$

table 20–2

Sequential Reactions in Gluconeogenesis Starting from Pyruvate*

Pyruvate + HCO_3^- + ATP ⟶ oxaloacetate + ADP + P_i + H^+	×2
Oxaloacetate + GTP ⇌ phosphoenolpyruvate + CO_2 + GDP	×2
Phosphoenolpyruvate + H_2O ⇌ 2-phosphoglycerate	×2
2-Phosphoglycerate ⇌ 3-phosphoglycerate	×2
3-Phosphoglycerate + ATP ⇌ 1,3-bisphosphoglycerate + ADP + H^+	×2
1,3-Bisphosphoglycerate + NADH + H^+ ⇌ glyceraldehyde 3-phosphate + NAD^+ + P_i	×2
Glyceraldehyde 3-phosphate ⇌ dihydroxyacetone phosphate	
Glyceraldehyde 3-phosphate + dihydroxyacetone phosphate ⇌ fructose 1,6-bisphosphate	
Fructose 1,6-bisphosphate + H_2O ⟶ fructose 6-phosphate + P_i	
Fructose 6-phosphate ⇌ glucose 6-phosphate	
Glucose 6-phosphate + H_2O ⟶ glucose + P_i	

Sum: 2 Pyruvate + 4ATP + 2GTP + 2NADH + $4H_2O$ ⟶ glucose + 4ADP + 2GDP + $6P_i$ + $2NAD^+$ + $2H^+$

*The bypass reactions are in red; all other reactions are reversible steps of glycolysis. The figures at the right indicate that the reaction is to be counted twice, because two three-carbon precursors are required to make a molecule of glucose. Note that the reactions required to replace the cytosolic NADH consumed in the glyceraldehyde 3-phosphate dehydrogenase reaction (the conversion of lactate to pyruvate in the cytosol or the transport of reducing equivalents from mitochondria to the cytosol in the form of malate) are not considered in this summary.

2 Piruvato + 4 ATP + 2 GTP + 2 NADH ⟶

1 Glucosa + 4 ADP + 2 GDP +6 Pi + 2 NAD^+

table 20–3

Glucogenic Amino Acids, Grouped by Site of Entry*

Pyruvate
Alanine
Cysteine
Glycine
Serine
Tryptophan†

α-Ketoglutarate
Arginine
Glutamate
Glutamine
Histidine
Proline

Succinyl-CoA
Isoleucine†
Methionine
Threonine
Valine

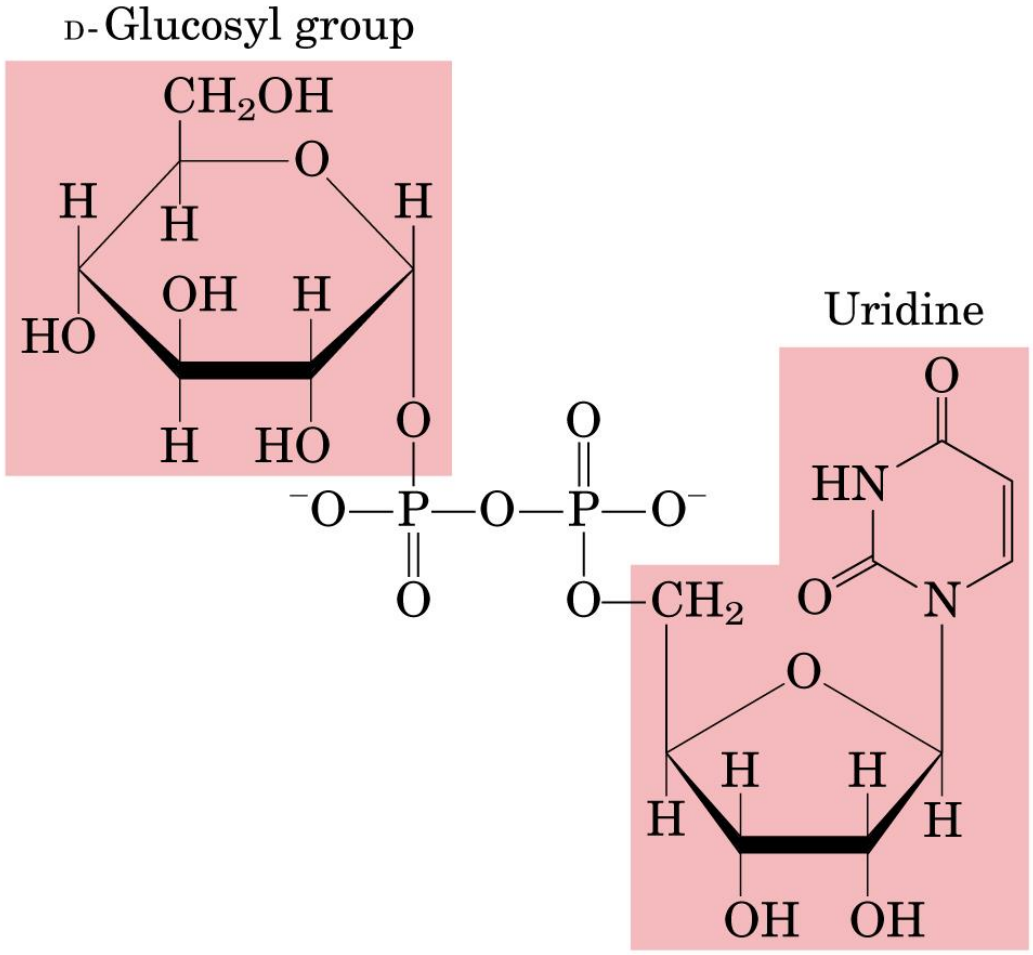
Fumarate
Phenylalanine†
Tyrosine†

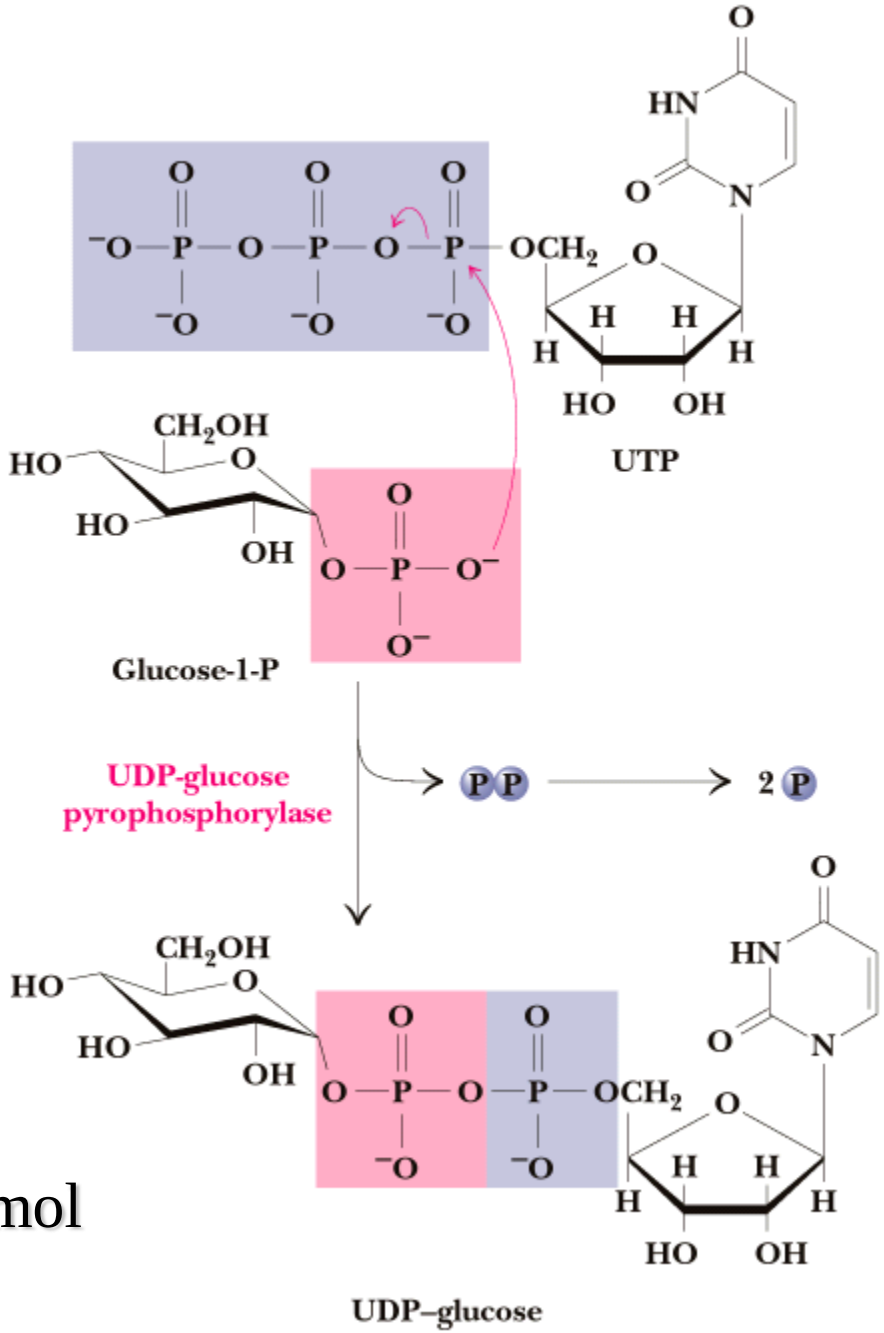
Oxaloacetate
Asparagine
Aspartate

*These amino acids are precursors of blood glucose or liver glycogen because they can be converted to pyruvate or citric acid cycle intermediates. Only leucine and lysine are unable to furnish carbon for net glucose synthesis.

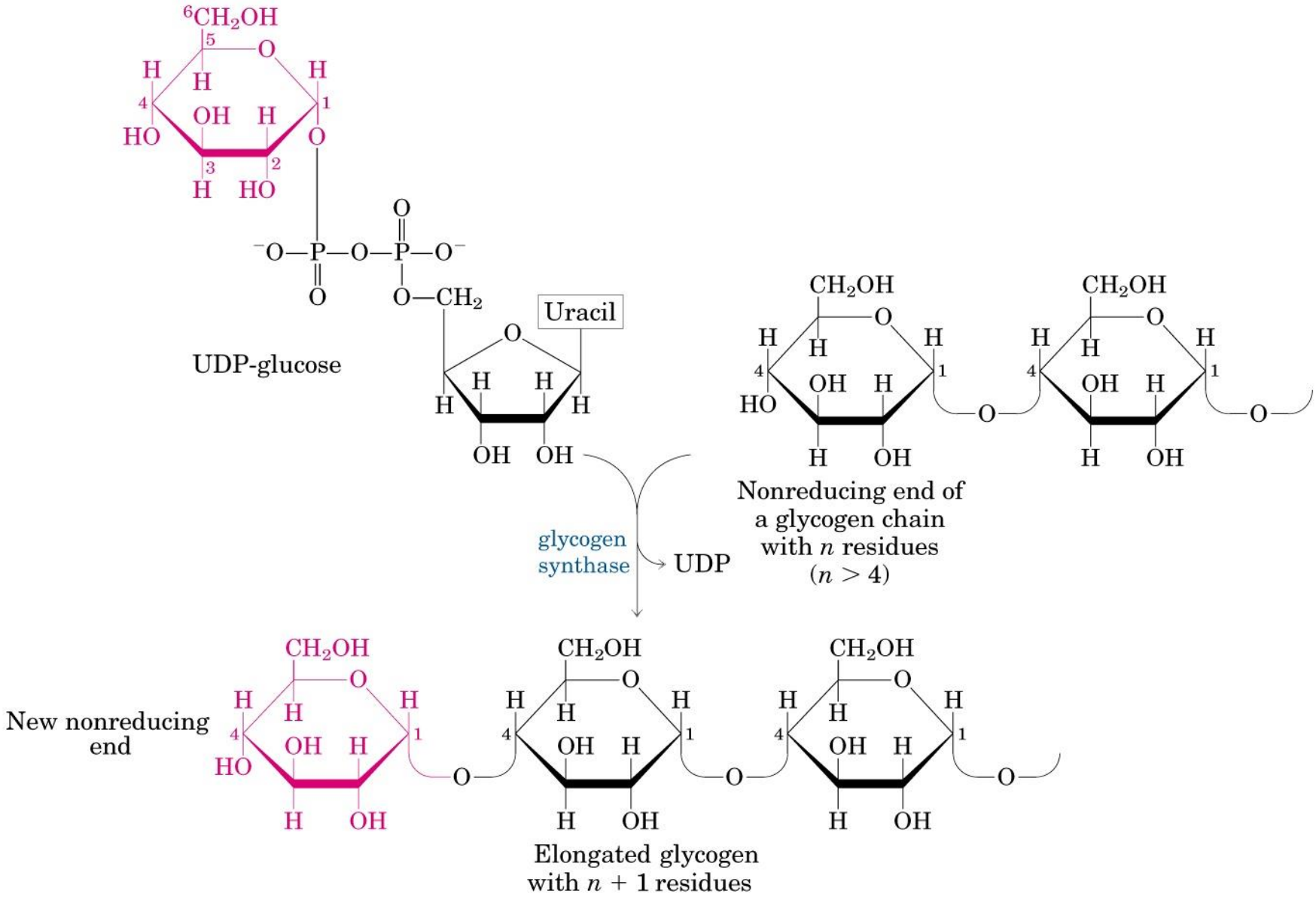
†These amino acids are also ketogenic (see Fig. 18–19).

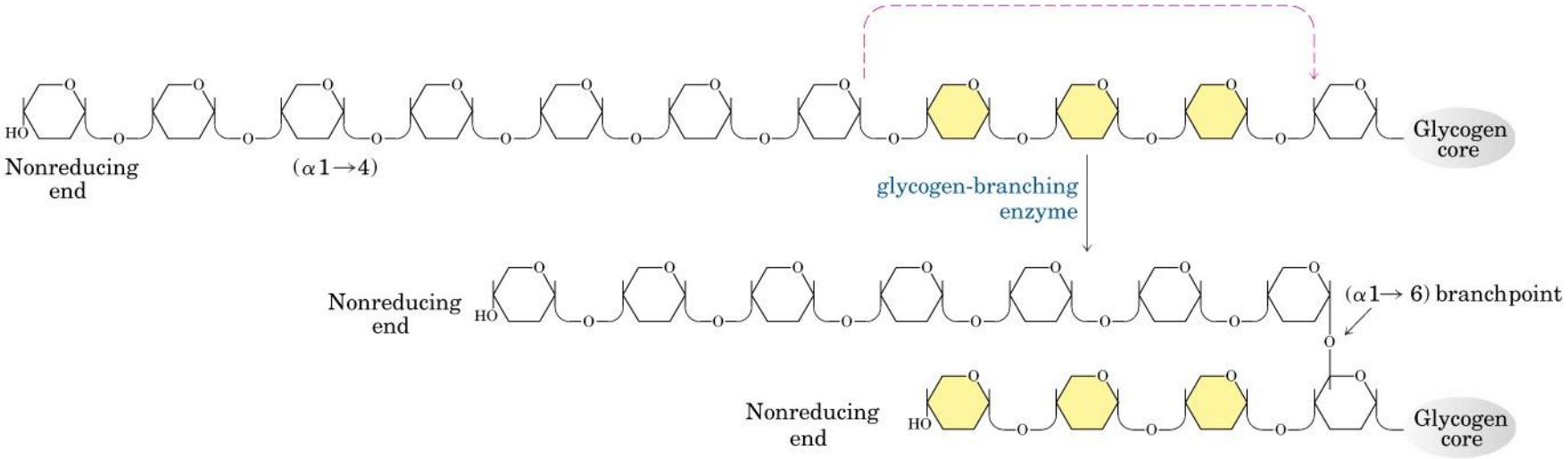
BIOSÍNTESIS DE GLUCÓGENO



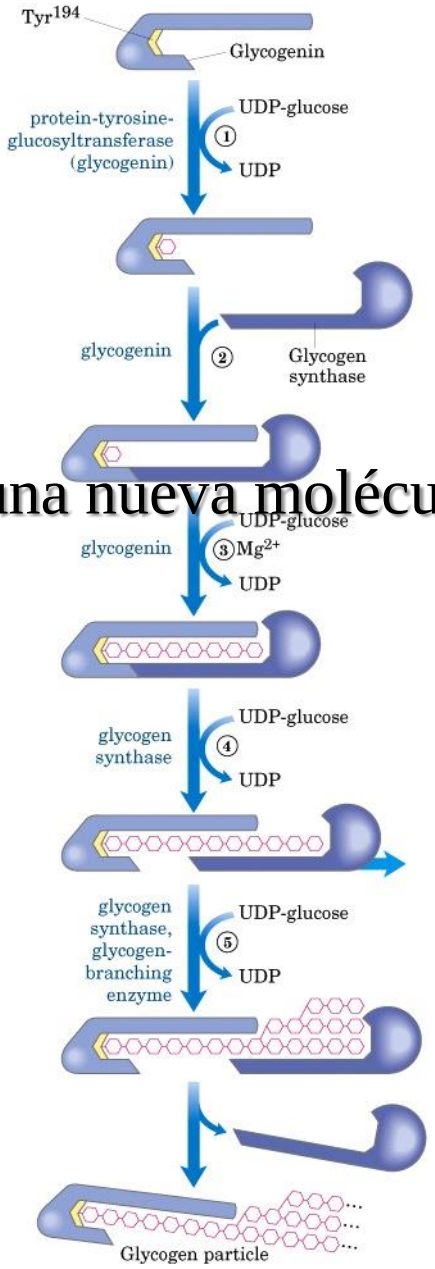


$\Delta G'^{o} = -25 kJ/mol$

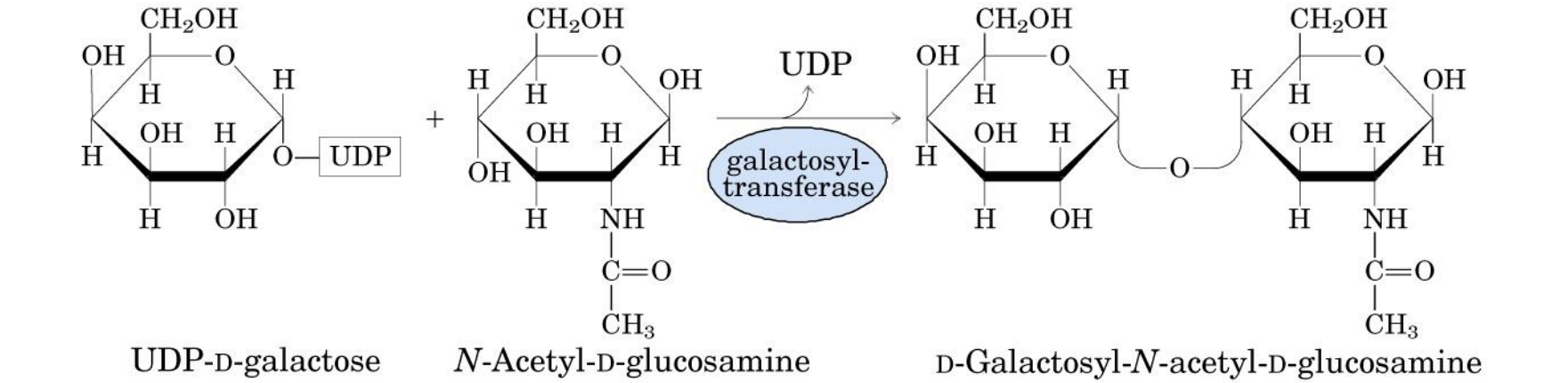

UDP-glucose
Uracil
glycogen synthase
UDP
Nonreducing end of a glycogen chain with n residues ($n > 4$)
New nonreducing end
Elongated glycogen with $n + 1$ residues


Nonreducing end
(α1→4)
Glycogen core
glycogen-branching enzyme
Nonreducing end
(α1→ 6) branchpoint
Nonreducing end
Glycogen core

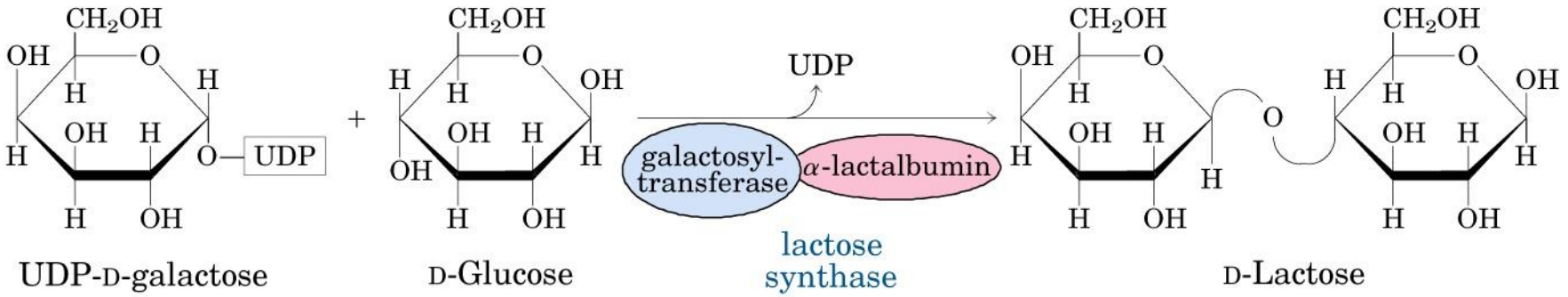
¿Cómo se inicia una nueva molécula de glucógeno?



Síntesis de lactosa



(a) Nonlactating tissues



(b) Lactating mammary gland

Síntesis de lactosa