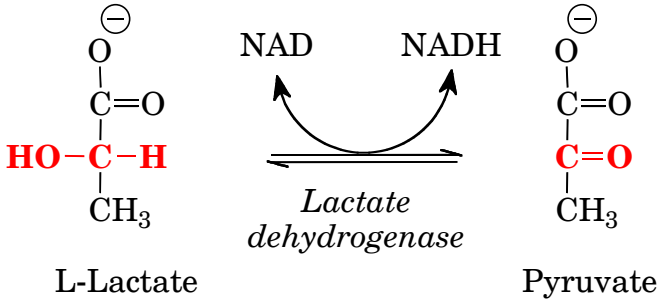
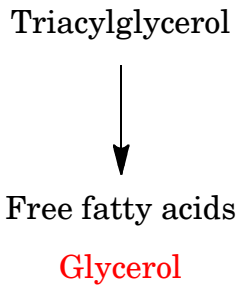
Gluconeogenesis

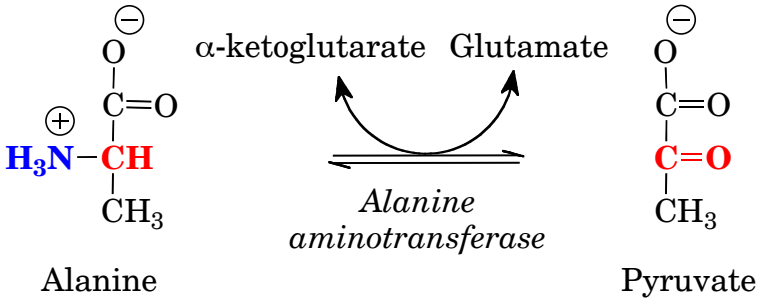
Glycolysis (aerobic)
Glucose + 2 ADP + 2 phosphate + 2 NAD → 2 Pyruvate + 2 ATP + 2 NADH + 2 H_2O

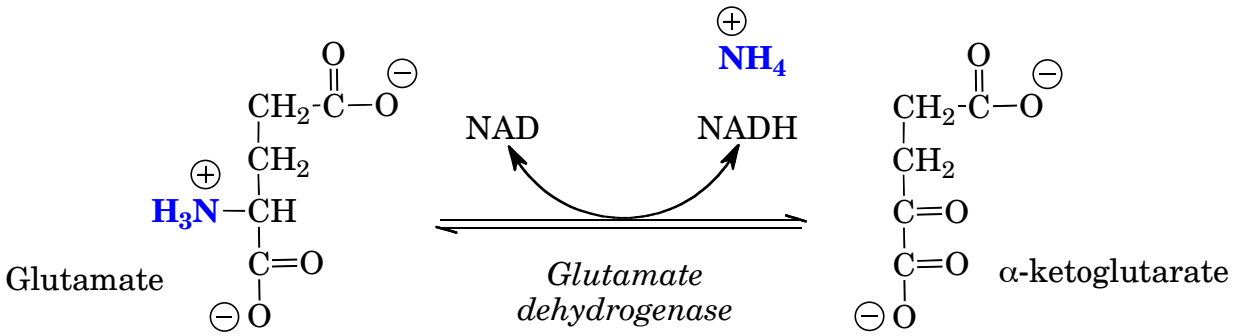
Gluconeogenesis
2 Pyruvate + 2 NADH + 4 ATP + 2 GTP → glucose + 2 NAD + 4 ADP + 2 GDP + 6 P_i

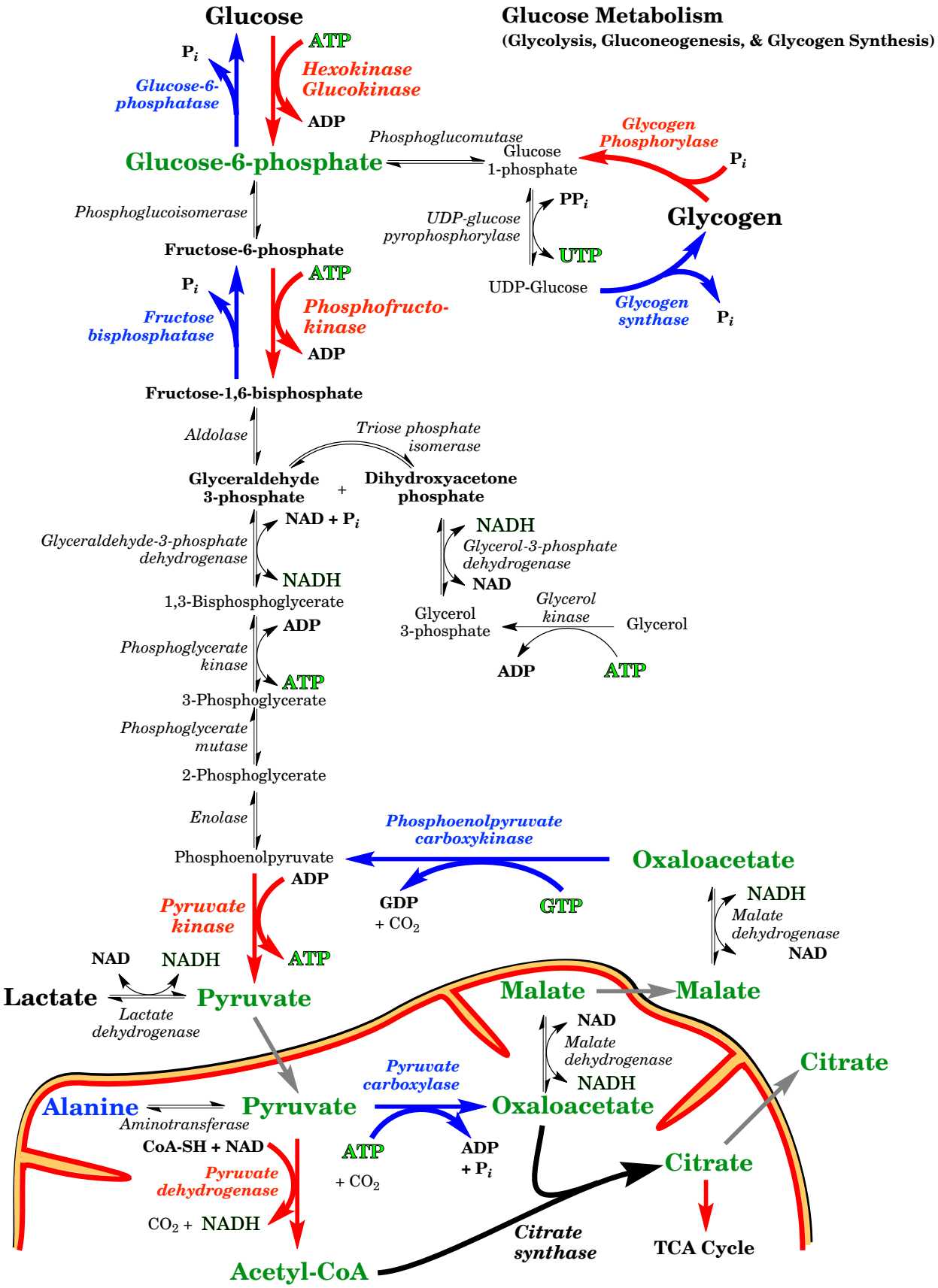
Substrates

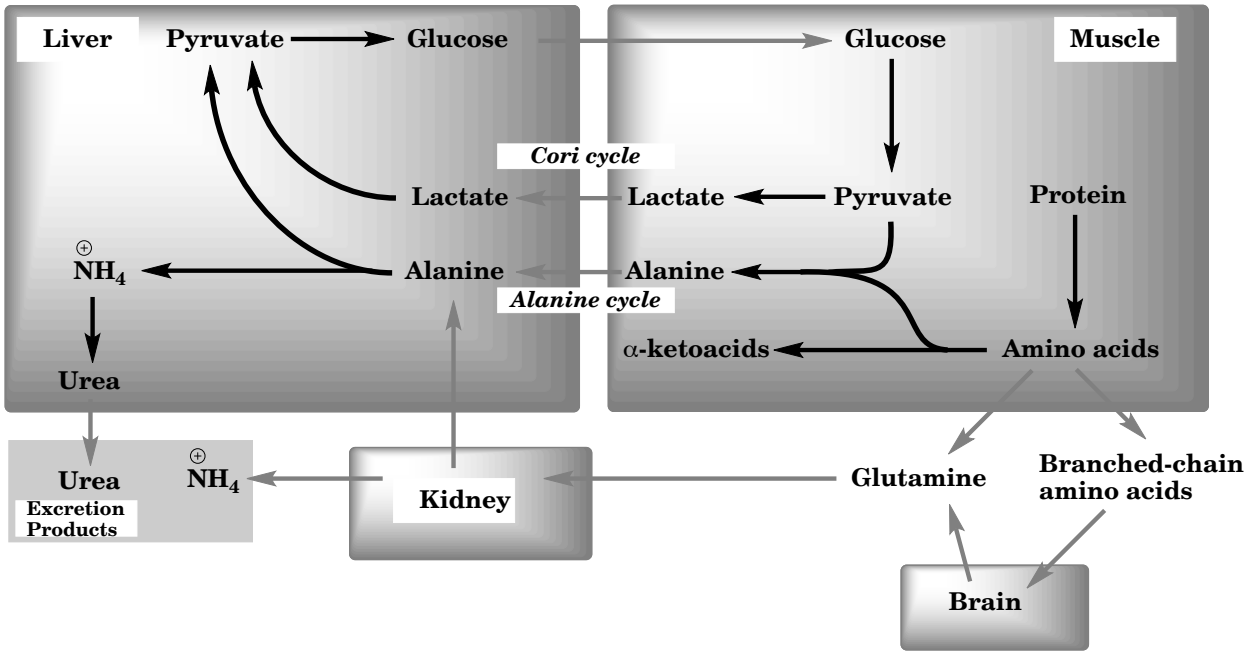




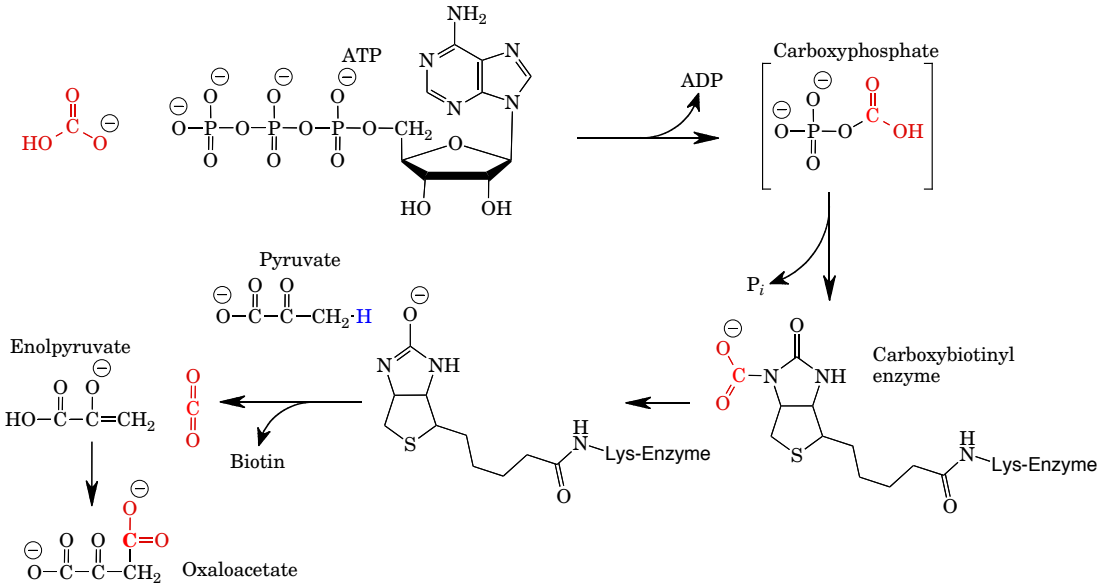


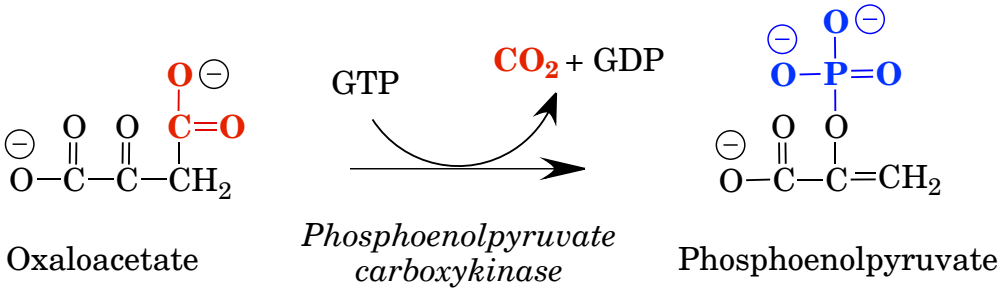



Glucose
Glucose Metabolism
(Glycolysis, Gluconeogenesis, & Glycogen Synthesis)
P$_i$
ATP
Glucose-6-phosphatase
Hexokinase
Glucokinase
ADP
Glucose-6-phosphate
Phosphoglucomutase
Glucose 1-phosphate
Glycogen Phosphorylase
P$_i$
Glycogen
Phosphoglucoisomerase
Fructose-6-phosphate
PP$_i$
UDP-glucose pyrophosphorylase
UTP
UDP-Glucose
Glycogen synthase
P$_i$
P$_i$
ATP
Fructose bisphosphatase
Phosphofructo-kinase
ADP
Fructose-1,6-bisphosphate
Aldolase
Triose phosphate isomerase
Glyceraldehyde 3-phosphate
+
Dihydroxyacetone phosphate
NAD + P$_i$
Glyceraldehyde-3-phosphate dehydrogenase
NADH
1,3-Bisphosphoglycerate
NADH
Glycerol-3-phosphate dehydrogenase
NAD
Glycerol 3-phosphate
Glycerol kinase
Glycerol
ADP
ATP
ADP
Phosphoglycerate kinase
ATP
3-Phosphoglycerate
Phosphoglycerate mutase
2-Phosphoglycerate
Enolase
Phosphoenolpyruvate
Phosphoenolpyruvate carboxykinase
Oxaloacetate
GDP
+ CO$_2$
GTP
ADP
Pyruvate kinase
ATP
NADH
Malate dehydrogenase
NAD
NAD
NADH
Lactate
Pyruvate
Lactate dehydrogenase
Malate
Malate
NAD
Malate dehydrogenase
NADH
Citrate
Pyruvate carboxylase
Alanine
Pyruvate
Oxaloacetate
Aminotransferase
CoA-SH + NAD
Pyruvate dehydrogenase
ATP
+ CO$_2$
ADP
+ P$_i$
Citrate
CO$_2$ + NADH
Citrate synthase
TCA Cycle
Acetyl-CoA

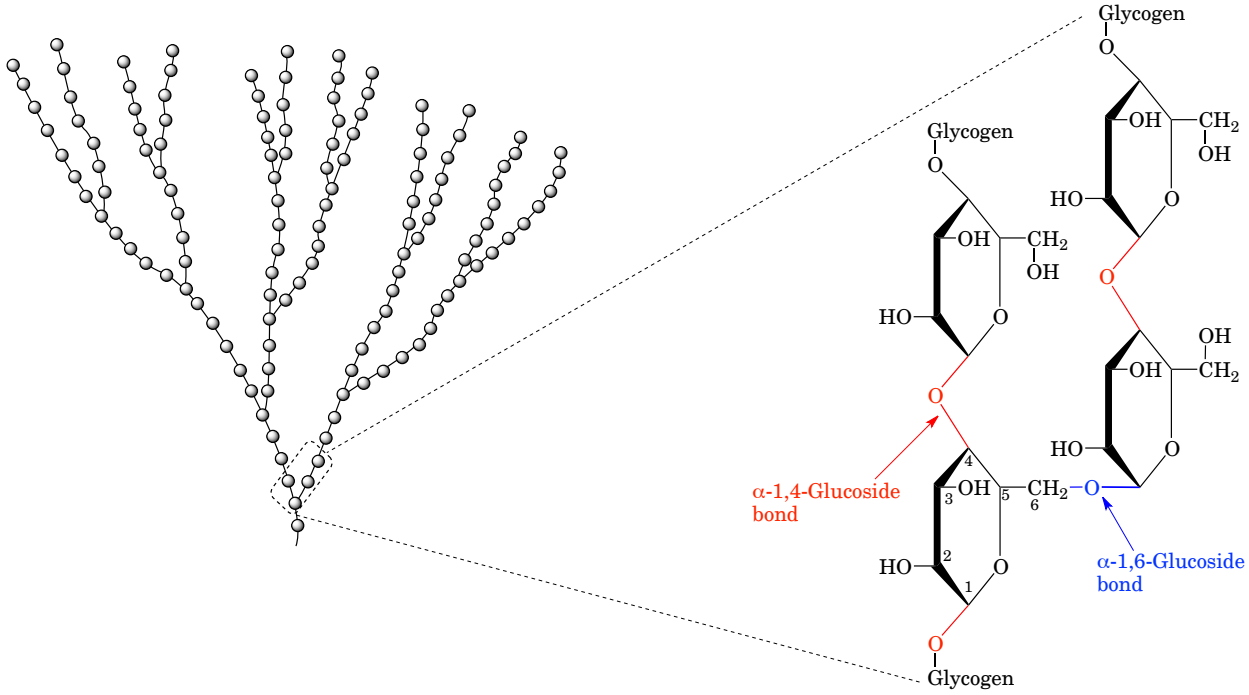


Synthesis of phosphoenolpyruvate from pyruvate

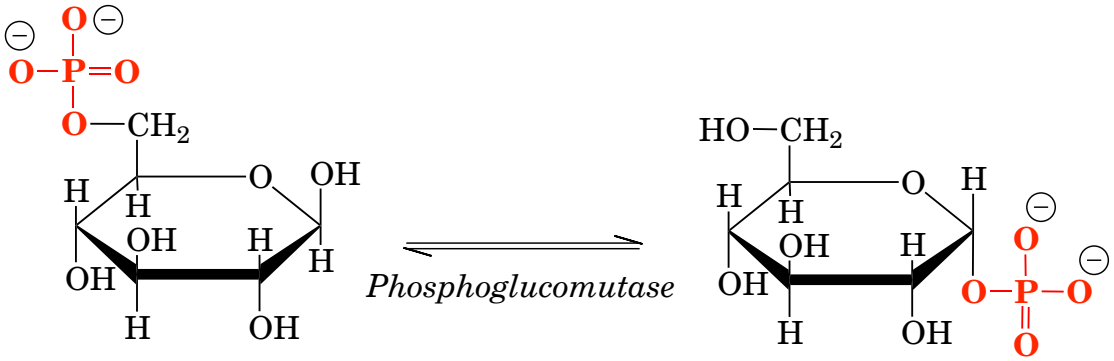




Glycogen

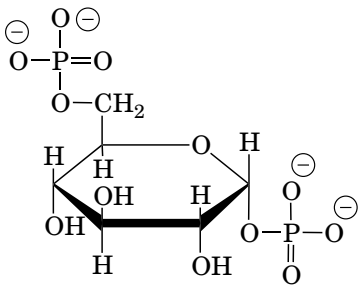


Glucose phosphate interconversion



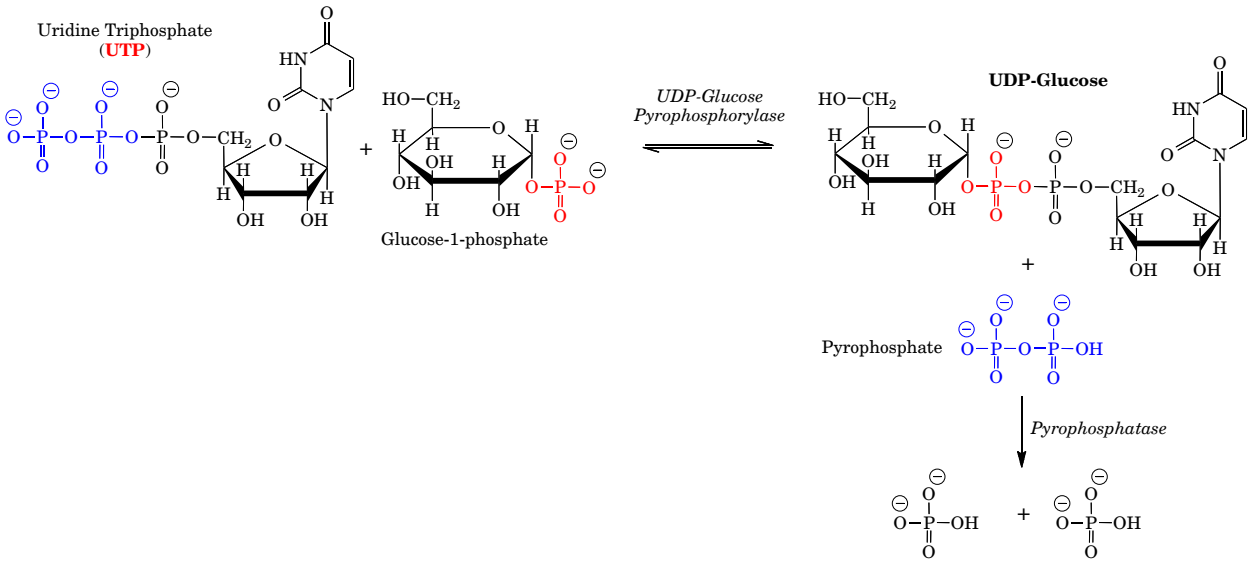
Glucose-6-phosphate

Glucose-1-phosphate



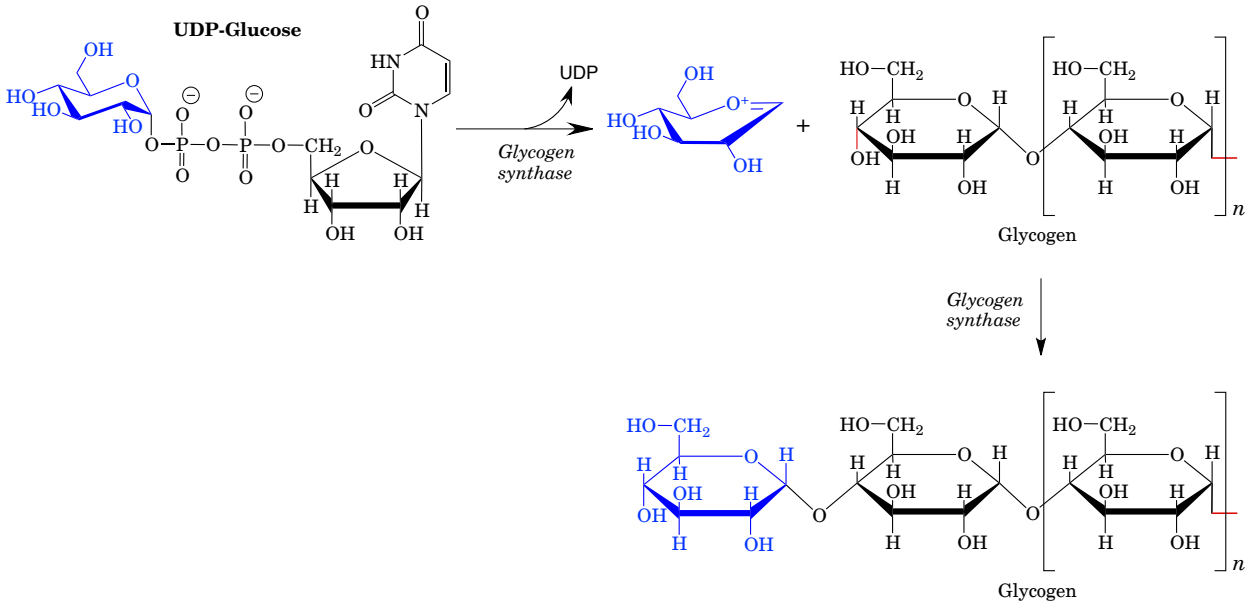
Glucose-1,6-bis-phosphate

Glycogen Synthesis

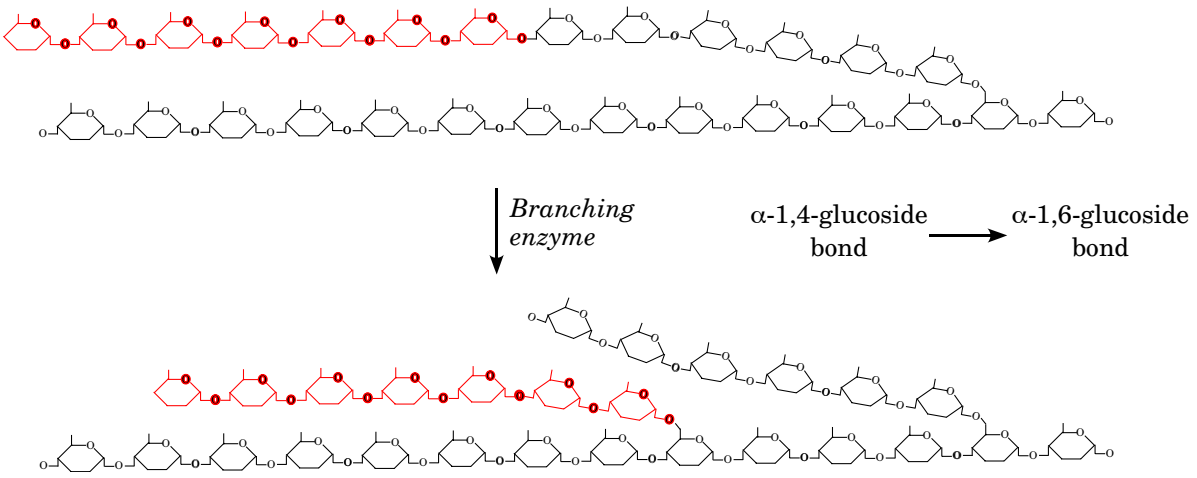


ADP-Glucose Pyrophosphorylase

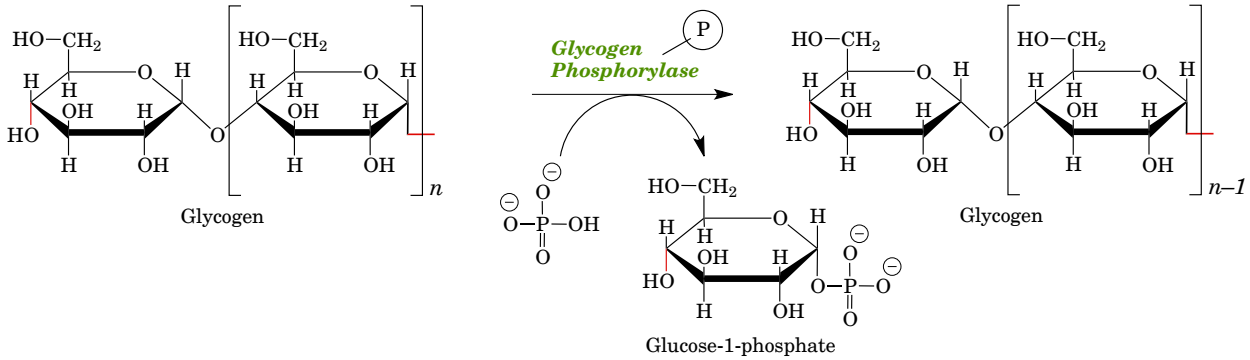
ATP + Glucose-1-Phosphate ⇌ ADP-Glucose + Pyrophosphate

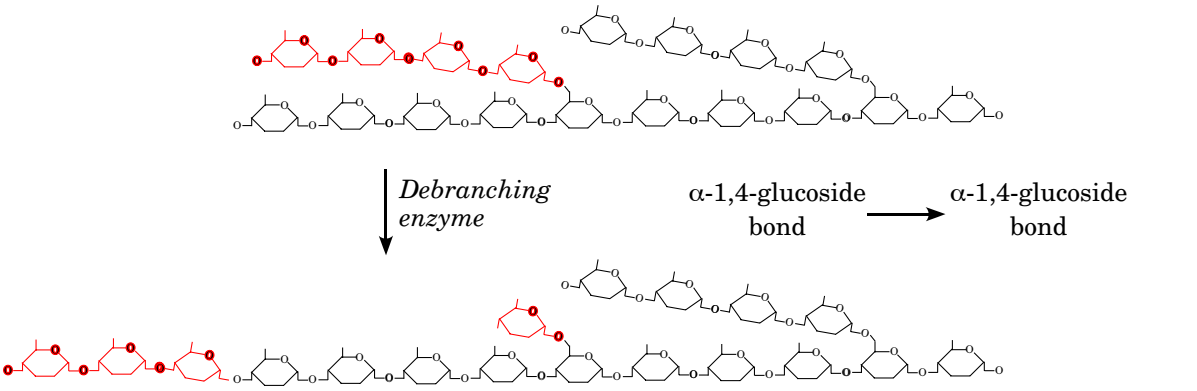


Branching



Glycogen Breakdown





Thermodynamic Considerations

Reaction	ΔG´° (kJ/mol)	ΔG (kJ/mol)
G-1-P + glycogen$_n$ → glycogen$_{n+1}$ + P$_i$	–3.1	+5 to +8 because [P$_i$] >> [G1P]
UDP-Glucose pyrophosphorylase G-1-P + UTP → UDPG + PP$_i$	0	
Pyrophosphatase PP$_i$ → 2 P$_i$	–33.5	
Glycogen synthase UDP + glycogen$_n$ → glycogen$_{n+1}$ + P$_i$	–13.4	
Glycogen phosphorylase *glycogen*$_n$ + *P$_i$* → *G-1-P* + *glycogen*$_{n-1}$	+3.1	–5 to –8 because [P$_i$] >> [G1P]
Hydrolysis of α(1→4)	–15.5	
Hydrolysis of α(1→6)	–7.1