



MCB 2000

EXAM 4 REACTIONS REVIEW

Glycolysis

TABLE 16.1 Reactions of glycolysis

Step	Reaction	Enzyme	Reaction type	$\Delta G^{\circ\prime}$ in kJ mol^{-1} (kcal mol^{-1})	ΔG in kJ mol^{-1} (kcal mol^{-1})
1	Glucose + ATP \longrightarrow glucose 6-phosphate + ADP + H ⁺	Hexokinase	Phosphoryl transfer	-16.7 (-4.0)	-33.5 (-8.0)
2	Glucose 6-phosphate \rightleftharpoons fructose 6-phosphate	Phosphoglucose isomerase	Isomerization	+1.7 (+0.4)	-2.5 (-0.6)
3	Fructose 6-phosphate + ATP \longrightarrow fructose 1,6-bisphosphate + ADP + H ⁺	Phosphofruktokinase	Phosphoryl transfer	-14.2 (-3.4)	-22.2 (-5.3)
4	Fructose 1,6-bisphosphate \rightleftharpoons dihydroxyacetone phosphate + glyceraldehyde 3-phosphate	Aldolase	Aldol cleavage	+23.8 (+5.7)	-1.3 (-0.3)
5	Dihydroxyacetone phosphate \rightleftharpoons glyceraldehyde 3-phosphate	Triose phosphate isomerase	Isomerization	+7.5 (+1.8)	+2.5 (+0.6)
6	Glyceraldehyde 3-phosphate + P _i + NAD ⁺ \rightleftharpoons 1,3-bisphosphoglycerate + NADH + H ⁺	Glyceraldehyde 3-phosphate dehydrogenase	Phosphorylation coupled to oxidation	+6.3 (+1.5)	-1.7 (-0.4)
7	1,3-Bisphosphoglycerate + ADP \rightleftharpoons 3-phosphoglycerate + ATP	Phosphoglycerate kinase	Phosphoryl transfer	-18.8 (-4.5)	+1.3 (+0.3)
8	3-Phosphoglycerate \rightleftharpoons 2-phosphoglycerate	Phosphoglycerate mutase	Phosphoryl shift	+4.6 (+1.1)	+0.8 (+0.2)
9	2-Phosphoglycerate \rightleftharpoons phosphoenolpyruvate + H ₂ O	Enolase	Dehydration	+1.7 (+0.4)	-3.3 (-0.8)
10	Phosphoenolpyruvate + ADP + H ⁺ \longrightarrow pyruvate + ATP	Pyruvate kinase	Phosphoryl transfer	-31.4 (-7.5)	-16.7 (-4.0)

Investment phase (spend 2 ATP)

Yield phase (gain 4 ATP total, net gain of 2)

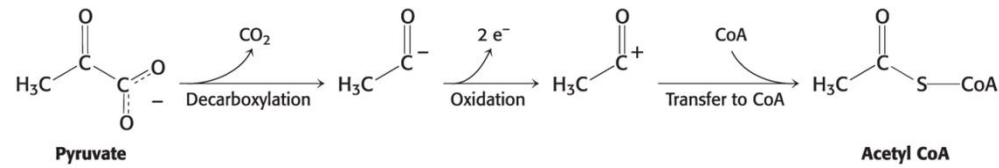
(Remember!! These steps are happening twice per 1 molecule of glucose)

* Irreversible reactions

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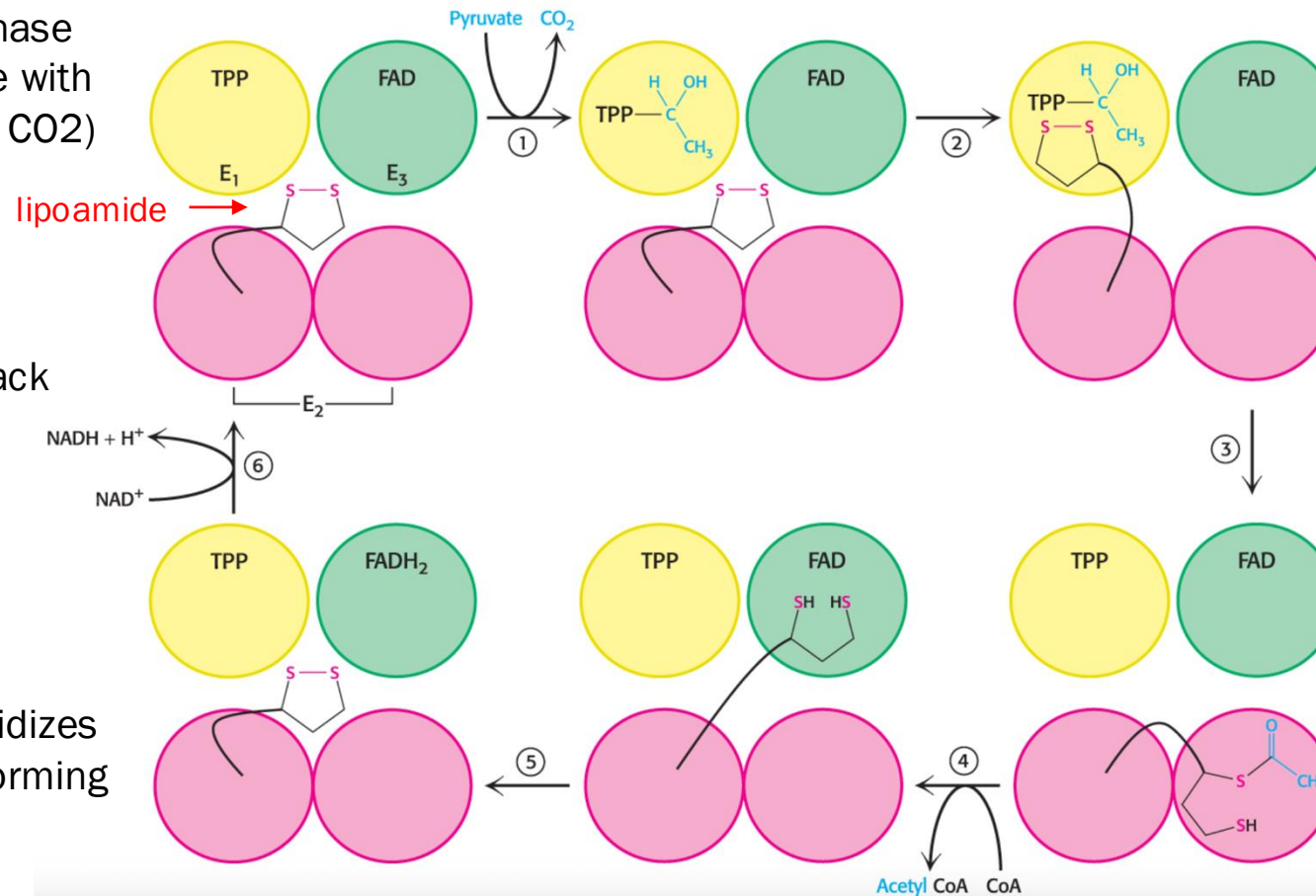
Net reaction:
 Glucose + 2 Pi + 2 ADP + 2 NAD⁺ \rightarrow 2 pyruvate + 2 ATP + 2 NADH + H₂O + 2 H⁺

*



Pyruvate Dehydrogenase Complex

1. Pyruvate dehydrogenase (E1) combines pyruvate with TPP (loses 1 carbon as CO₂)



2. The hydroxyethyl (CH₃CHOH) group attached to TPP is oxidized to an acetyl group while being transferred to lipoamide (also done by E1)

6. FADH₂ is oxidized back to FAD by NAD⁺

3. The acetyl-lipoamide arm swings to the active site (transacetylase domain) of dihydrolipoyl transacetylase (E2)

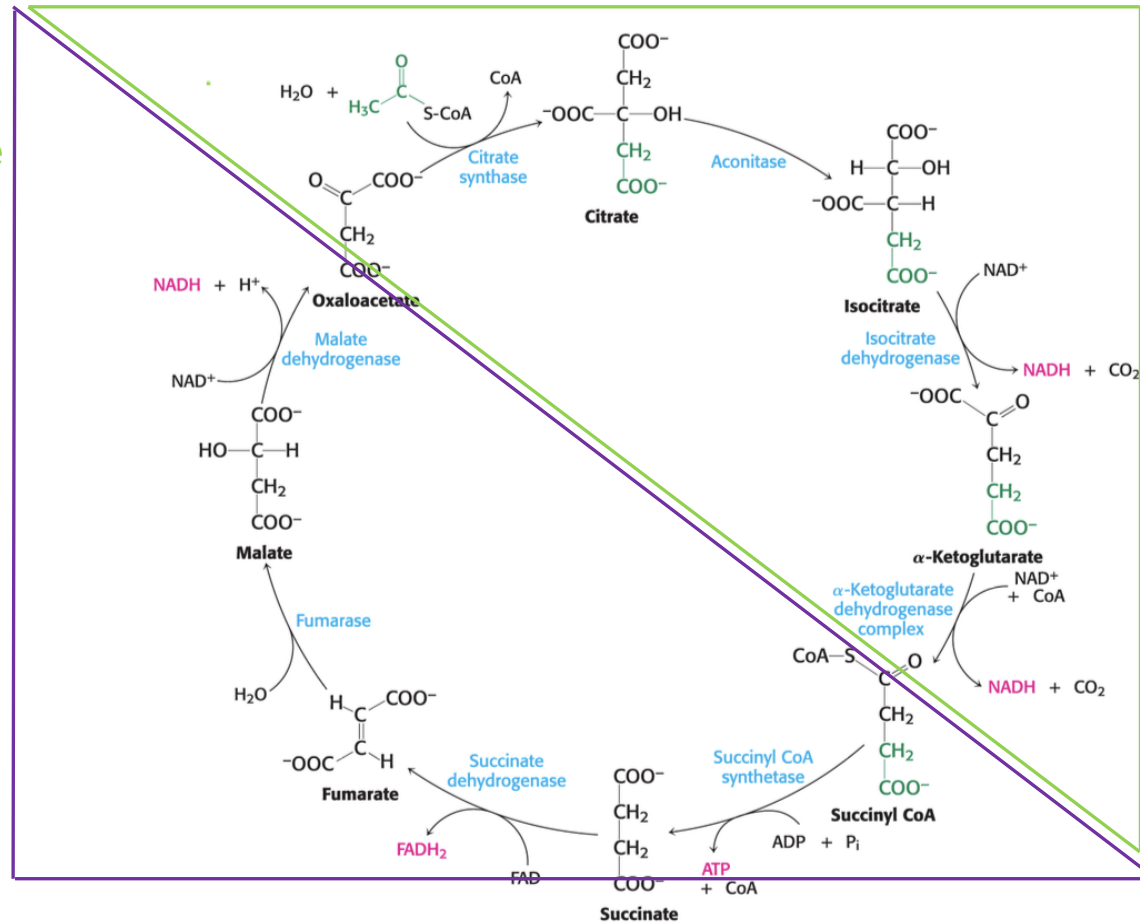
5. Dihydrolipoamide dehydrogenase (E3) oxidizes lipoamide using FAD, forming FADH₂

4. The acetyl group is transferred from lipoamide to Coenzyme A by E2, forming acetyl-CoA

Citric Acid/TCA Cycle

Stage 1: Acetyl CoA combines with oxaloacetate to make a 6-carbon molecule (citrate), then releases two carbons as CO₂

Stage 2: Regeneration of oxaloacetate + generation of one ATP

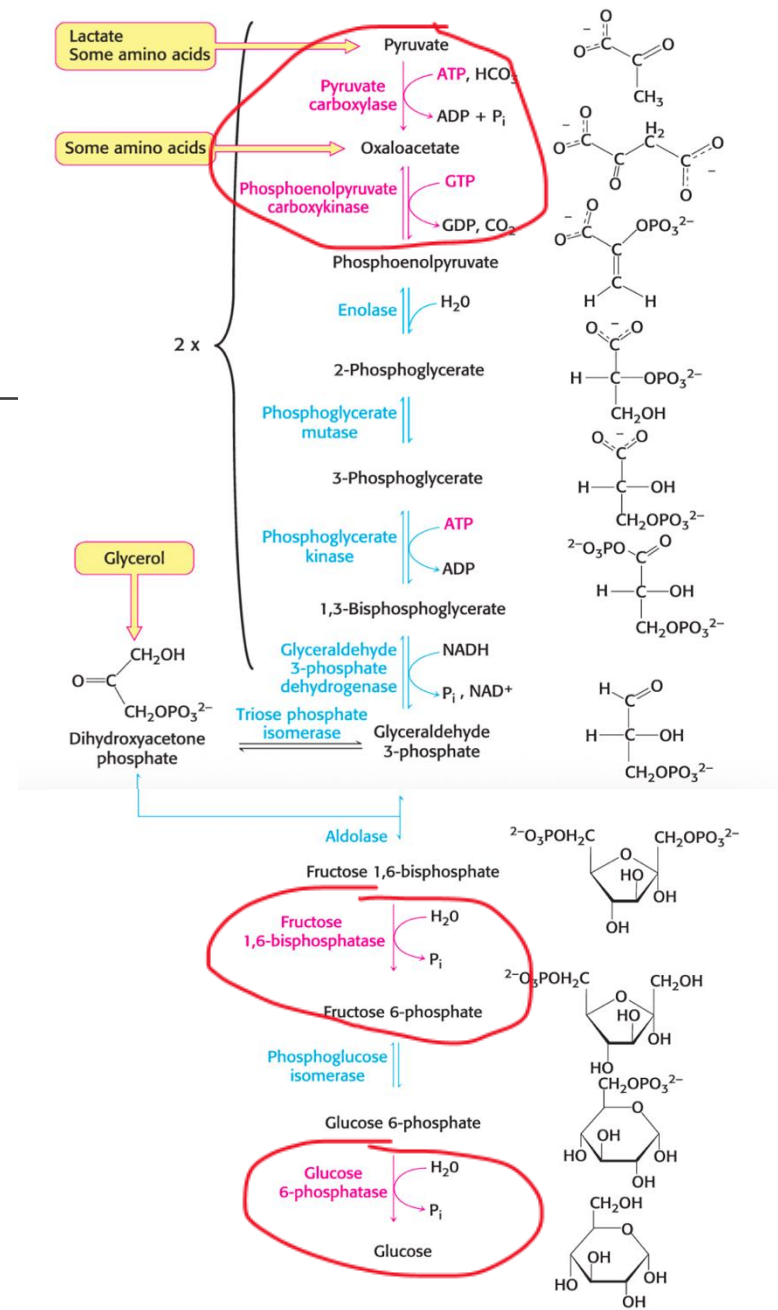


Products of ONE turn of the cycle (1 acetyl-CoA):
2 CO₂, 3 NADH, 1 FADH₂, 1 ATP

1 NADH = 2.5 ATP
1 FADH₂ = 1.5 ATP
Total ATP generated =
(3 x 2.5) + (1 x 1.5) +
1 = 10 ATP

Gluconeogenesis

- Essentially glycolysis in reverse, but four new enzymes are included to convert pyruvate to oxaloacetate and to bypass the three irreversible glycolysis reactions (steps 1, 3, and 10)



Resources

- Glycolysis
 - <https://www.khanacademy.org/science/biology/cellular-respiration-and-fermentation/glycolysis/v/glycolysis-overview>
 - <https://www.khanacademy.org/test-prep/mcat/biomolecules/carbohydrate-metabolism/e/carbohydrate-metabolism-questions>
- Gluconeogenesis
 - <https://www.khanacademy.org/test-prep/mcat/biomolecules/carbohydrate-metabolism/v/gluconeogenesis-unique-reactions>
- PDH Complex
 - <https://www.youtube.com/watch?v=AuXkMmxFpf8> (discussion of PDH starts at 8:09)
 - <https://quizlet.com/75226830/pyruvate-dehydrogenase-complex-flash-cards/>
- TCA Cycle
 - <https://www.khanacademy.org/science/biology/cellular-respiration-and-fermentation/pyruvate-oxidation-and-the-citric-acid-cycle/v/krebs-citric-acid-cycle>
 - <https://www.khanacademy.org/test-prep/mcat/biomolecules/krebs-citric-acid-cycle-and-oxidative-phosphorylation/e/krebs-citric-acid-cycle-and-oxidative-phosphorylation-questions>

Resources

- Reaction Flashcards
 - Glycolysis: <https://quizlet.com/16319761/10-steps-of-glycolysis-flash-cards/>
 - Gluconeogenesis: <https://quizlet.com/1009421604/gluconeogenesis-steps-flash-cards/>
 - TCA: <https://quizlet.com/93634592/tca-cycle-enzymes-flash-cards/>