18.3B: Transition Reaction

Learning Objectives

1. Briefly describe the function of transition reaction during aerobic respiration and indicate the reactants and products.
2. During aerobic respiration, state what happens to the 2 NADH produced during the transition reaction.
3. Compare where the transition reaction occurs in prokaryotic cells and in eukaryotic cells.
4. During aerobic respiration, state what happens to the two molecules of Acetyl-CoA produced during the transition reaction.

Formation of Acetyl-CoA through the Transition Reaction

The transition reaction connects glycolysis to the citric acid (Krebs) cycle. Through a process called oxidative decarboxylation, the transition reaction converts the two molecules of the 3-carbon pyruvate from glycolysis (and other pathways) into two molecules of the 2-carbon molecule acetyl Coenzyme A (acetyl-CoA) and 2 molecules of carbon dioxide. First, a carboxyl group of each pyruvate is removed as carbon dioxide and then the remaining acetyl group combines with coenzyme A (CoA) to form acetyl-CoA.
The Transition Reaction between Glycolysis and the Citric Acid Cycle. Before the pyruvates from glycolysis can enter the citric acid cycle, they must undergo a transition reaction. The 3-carbon pyruvate is converted into a 2-carbon acetyl group with a carboxyl being removed as CO$_2$. The acetyl group is attached to coenzyme A to form acetyl coenzyme A (acetyl-CoA), a key precursor metabolite. As the two acetyl groups become oxidized to acetyl-CoA, two molecules of NAD$^+$ are reduced to 2NADH + 2H$^+$. As the two pyruvates undergo oxidative decarboxylation, two molecules of NAD$^+$ become reduced to 2NADH + 2H$^+$ (Figures \(\PageIndex{1}\) and \(\PageIndex{2}\)). The 2NADH + 2H$^+$ carry protons and electrons to the electron transport chain to generate additional ATP by oxidative phosphorylation.

The overall reaction for the transition reaction is:

$$2 \text{ pyruvate} + 2 \text{ NAD}^+ + 2 \text{ coenzyme A}$$

$$\text{yields} 2 \text{ acetyl-CoA} + 2 \text{ NADH} + 2 \text{ H}^+ + 2 \text{ CO}_2$$

In prokaryotic cells, the transition step occurs in the cytoplasm; in eukaryotic cells the pyruvates must first enter the mitochondria because the transition reaction and the citric acid cycle take place in the matrix of the mitochondria.

The two molecules of acetyl-CoA can now enter the citric acid cycle. Acetyl-CoA is also a precursor metabolite for fatty acid synthesis, as shown in Figure \(\PageIndex{3}\)).
Figure \(\PageIndex{3}\): Integration of Metabolism - Precursor Metabolites. Carbohydrates, proteins, and lipids can be used as energy sources; metabolites involved in energy production can be used to synthesize carbohydrates, proteins, lipids, nucleic acids, and cellular structures.

**Summary**

1. Aerobic respiration involves four stages: glycolysis, a transition reaction that forms acetyl coenzyme A, the citric acid (Krebs) cycle, and an electron transport chain and chemiosmosis.
2. The transition reaction connects glycolysis to the citric acid (Krebs) cycle.
3. The transition reaction converts the two molecules of the 3-carbon pyruvate from glycolysis (and other pathways) into two molecules of the 2-carbon molecule acetyl Coenzyme A (acetyl-CoA) and 2 molecules of carbon dioxide.
4. As the two pyruvates undergo oxidative decarboxylation, two molecules of NAD\(^+\) become reduced to 2NADH + 2H\(^+\) which carry protons and electrons to the electron transport chain to generate additional ATP by oxidative phosphorylation.
5. The overall reaction for the transition reaction is: 2 pyruvate + 2 NAD\(^+\) + 2 coenzyme A yields 2 acetyl-CoA + 2 NADH + 2 H\(^+\) + 2 CO\(_2\).
6. The two molecules of acetyl-CoA can now enter the citric acid cycle.

**Contributors and Attributions**

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