The Citric Acid Cycle Practice Test (Sample)

Study Guide

BY EXAMZIFY

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Questions

1. **What is another term for an amino acid that can be converted into glucose?**

   A. Ketogenic amino acid

   B. Non-essential amino acid

   C. Glycogenic amino acid

   D. Essential amino acid

2. **What are the main products of one turn of the Citric Acid Cycle?**

   A. 2 NADH, 1 FADH2, and 1 ATP

   B. 3 NADH, 1 FADH2, 1 GTP (or ATP), and 2 CO2

   C. 4 NADH, 2 FADH2, and 1 ATP

   D. 1 NADH, 2 FADH2, and 3 CO2

3. **What type of reaction occurs when succinate is converted to fumarate in the Citric Acid Cycle?**

   A. A hydration reaction

   B. A dehydrogenation reaction

   C. A condensation reaction

   D. An oxidation reaction

4. **What is the main output of the Citric Acid Cycle in terms of ATP equivalents?**

   A. Two GTP equivalents per cycle

   B. Three ATP equivalents per cycle

   C. One GTP (or ATP) equivalent per cycle

   D. Four GTP equivalents per cycle

5. **What role does the ADP:ATP ratio play in the citric acid cycle?**

   A. It regulates enzyme activity

   B. It affects substrate concentration

   C. It determines oxygen availability

   D. It controls the pH of the cycle

6. **Which of the following is NOT a key enzyme of the citric acid cycle?**
   - A. Citrate synthase
   - B. Isocitrate dehydrogenase
   - C. Succinyl CoA synthetase
   - D. Hexokinase

7. **Which compound is formed during the hydration of fumarate?**
   - A. Citrate
   - B. Oxaloacetate
   - C. Malate
   - D. Succinate

8. **What type of bond is broken to release energy during the conversion of succinyl CoA to succinate?**
   - A. Thioester bond
   - B. Peptide bond
   - C. Hydrogen bond
   - D. Ionic bond

9. **What synthesizes Acetyl CoA primarily during fasting states in most tissues?**
   - A. Glycolysis
   - B. Pantothenic acid metabolism
   - C. Fatty acid breakdown
   - D. Protein catabolism

10. **What is the role of acetyl-CoA in the Citric Acid Cycle?**
   - A. It acts as a waste product
   - B. It serves as a substrate that combines with oxaloacetate
   - C. It regulates enzyme activity
   - D. It converts NADH to NAD+

Answers

1. **C**
2. **B**
3. **B**
4. **C**
5. **A**
6. **D**
7. **C**
8. **A**
9. **C**
10. **B**

Explanations

1. What is another term for an amino acid that can be converted into glucose?

A. Ketogenic amino acid

B. Non-essential amino acid

C. Glycogenic amino acid

D. Essential amino acid

The correct term for an amino acid that can be converted into glucose is glycogenic amino acid. Glycogenic amino acids can be utilized in gluconeogenesis, the metabolic process where glucose is synthesized from non-carbohydrate precursors. This conversion occurs primarily in the liver and is crucial for maintaining blood glucose levels during fasting or intense exercise. Glycogenic amino acids can be converted to intermediates that enter the glycolytic pathway or directly into glucose itself. Common examples of glycogenic amino acids include alanine and glutamine. Understanding the role of these amino acids is important in the context of energy metabolism and the body's ability to maintain glucose homeostasis.

2. What are the main products of one turn of the Citric Acid Cycle?

A. 2 NADH, 1 FADH2, and 1 ATP

B. 3 NADH, 1 FADH2, 1 GTP (or ATP), and 2 CO2

C. 4 NADH, 2 FADH2, and 1 ATP

D. 1 NADH, 2 FADH2, and 3 CO2

The main products of one turn of the Citric Acid Cycle, also known as the Krebs Cycle, include three molecules of NADH, one molecule of FADH2, one GTP (which can be readily converted to ATP), and the release of two molecules of carbon dioxide (CO2).   NADH and FADH2 are vital because they carry high-energy electrons to the electron transport chain, where their energy is harnessed to produce ATP. The generation of GTP or ATP is crucial for cellular energy, supporting various biological processes. The release of two CO2 molecules is part of the cycle's role in metabolizing organic fuel molecules, representing the decarboxylation processes that occur as the cycle progresses. This combination of products is a key characteristic of the cycle, reflecting its role in both energy production and the biosynthesis of various molecules in the cell.

3. What type of reaction occurs when succinate is converted to fumarate in the Citric Acid Cycle?

A. A hydration reaction

B. A dehydrogenation reaction

C. A condensation reaction

D. An oxidation reaction

The conversion of succinate to fumarate in the Citric Acid Cycle is classified as a dehydrogenation reaction. This type of reaction involves the removal of hydrogen atoms from a molecule, which in this context results in the conversion of the saturated four-carbon compound succinate into the unsaturated four-carbon compound fumarate. During this transformation, succinate loses two hydrogen atoms, which are transferred to a molecule of FAD (flavin adenine dinucleotide), reducing it to FADH2. This step is crucial because the electron carriers are integral to the pathway, facilitating the subsequent steps in the Citric Acid Cycle by contributing to the electron transport chain where ATP is ultimately produced. Thus, identifying this reaction as a dehydrogenation emphasizes the role of electron transfer and oxidation-reduction processes in the cycle.

4. What is the main output of the Citric Acid Cycle in terms of ATP equivalents?

A. Two GTP equivalents per cycle

B. Three ATP equivalents per cycle

C. One GTP (or ATP) equivalent per cycle

D. Four GTP equivalents per cycle

The main output of the Citric Acid Cycle, also known as the Krebs cycle or TCA cycle, includes a direct generation of one GTP (which is energetically equivalent to ATP) per cycle. This process occurs during the conversion of succinyl-CoA to succinate, where GTP is produced through substrate-level phosphorylation. In the context of the Citric Acid Cycle, it's important to recognize that while the cycle does lead to the production of reduced cofactors, specifically three NADH and one FADH2 per cycle, these do not directly represent ATP equivalents in the same way GTP does. The NADH and FADH2 will later contribute to ATP production during oxidative phosphorylation in the electron transport chain, leading to an approximate yield of additional ATP based on the reduced cofactors. However, the specific question focuses on the direct output from the cycle itself, solidifying that one GTP (or ATP) equivalent is the primary measure for output per round of the cycle.

5. What role does the ADP:ATP ratio play in the citric acid cycle?

A. It regulates enzyme activity

B. It affects substrate concentration

C. It determines oxygen availability

D. It controls the pH of the cycle

The ADP:ATP ratio plays a crucial role in regulating enzyme activity within the citric acid cycle, which is an integral part of cellular respiration. When the ratio of ADP to ATP is high, it indicates that energy levels in the cell are low and that there is a demand for ATP synthesis. This high ADP concentration activates key enzymes in the cycle to increase the rate of reactions that produce more ATP. For instance, enzymes like isocitrate dehydrogenase and alpha-ketoglutarate dehydrogenase are stimulated by ADP, enhancing their activity and subsequently facilitating the flow of the cycle to generate more high-energy molecules. Conversely, when ATP levels are sufficient (reflected by a low ADP:ATP ratio), the cycle slows down, conserving resources and preventing excessive metabolite production. This mechanism maintains a balance between energy production and the energy needs of the cell, highlighting how metabolite concentrations can influence metabolic pathways directly. The regulatory role of the ADP:ATP ratio is fundamental to the energy management of the cell and its metabolic efficiency.

6. Which of the following is NOT a key enzyme of the citric acid cycle?

A. Citrate synthase

B. Isocitrate dehydrogenase

C. Succinyl CoA synthetase

D. Hexokinase

The correct answer is that hexokinase is not a key enzyme of the citric acid cycle. Hexokinase plays a crucial role in the glycolytic pathway, where it catalyzes the phosphorylation of glucose to form glucose-6-phosphate, facilitating its entry into glycolysis. While important for energy metabolism, hexokinase does not directly participate in the reactions of the citric acid cycle. In contrast, citrate synthase, isocitrate dehydrogenase, and succinyl CoA synthetase are all essential enzymes within the citric acid cycle. Citrate synthase catalyzes the condensation of acetyl-CoA with oxaloacetate to form citrate, thereby initiating the cycle. Isocitrate dehydrogenase plays a significant role in the oxidative decarboxylation of isocitrate to α-ketoglutarate, producing NADH and releasing carbon dioxide. Succinyl CoA synthetase is involved in the conversion of succinyl-CoA to succinate, coupled with the generation of GTP (or ATP), another important step in the cycle. These enzymes are integral to the overall function and progression of the citric acid cycle, which is critical for cellular respiration and energy production in

7. Which compound is formed during the hydration of fumarate?

A. Citrate

B. Oxaloacetate

C. Malate

D. Succinate

During the hydration of fumarate, the compound that is formed is malate. This step is an important part of the citric acid cycle, where fumarate, which is a double-bonded compound, undergoes the addition of water (hydration). The enzymatic reaction facilitated by fumarase adds a hydroxyl group and a hydrogen atom across the double bond of fumarate, resulting specifically in malate, which is a three-carbon compound with a hydroxyl group attached. This transformation is key in the cycle as it enables the subsequent conversion of malate to oxaloacetate, allowing the cycle to continue. Understanding this process emphasizes the role of hydration in organic reactions and how it pertains specifically to the metabolism of carbohydrates and energy production in the citric acid cycle.

8. What type of bond is broken to release energy during the conversion of succinyl CoA to succinate?

A. Thioester bond

B. Peptide bond

C. Hydrogen bond

D. Ionic bond

The conversion of succinyl CoA to succinate involves the breaking of a thioester bond. Thioester bonds are a type of high-energy bond found in molecules like succinyl CoA, which is generated during the Krebs cycle. When the bond is broken, it releases a significant amount of energy that is utilized for various cellular processes. This reaction is catalyzed by the enzyme succinyl-CoA synthetase, and the energy released from the thioester bond is harnessed to drive the synthesis of ATP from ADP and inorganic phosphate, or in some organisms, GTP from GDP and inorganic phosphate. The ability of thioester bonds to release energy upon hydrolysis is fundamental to the energy transformations that occur in the citric acid cycle, allowing for the continuation of this metabolic pathway and contributing to the overall production of ATP in cellular respiration. In contrast, peptide bonds relate to protein structure and do not play a role in this particular reaction, while hydrogen bonds and ionic bonds are generally more relevant to molecular interactions and stability rather than the release of energy through bond cleavage in this context.

9. What synthesizes Acetyl CoA primarily during fasting states in most tissues?

A. Glycolysis

B. Pantothenic acid metabolism

C. Fatty acid breakdown

D. Protein catabolism

Acetyl CoA is a crucial molecule that plays a significant role in cellular metabolism, particularly in energy production via the Citric Acid Cycle. During fasting states, the body undergoes various metabolic adaptations to maintain energy balance and supply necessary substrates for essential physiological processes. In this context, the breakdown of fatty acids becomes the primary source of Acetyl CoA. When carbohydrates are scarce during fasting, the body shifts from relying on glucose to utilizing stored fat as an energy source. Fatty acids, which are released from adipose tissue, undergo a process called beta-oxidation within the mitochondria of cells. This process entails the sequential removal of two-carbon units from the fatty acid chain, resulting in the continuous conversion of fatty acids into Acetyl CoA. Once formed, Acetyl CoA can either enter the Citric Acid Cycle to produce ATP and other energy-rich compounds or be used for ketogenesis, where some of it is converted into ketone bodies for use by other tissues, particularly the brain. Thus, during fasting states, the synthesis of Acetyl CoA primarily occurs through fatty acid breakdown, leveraging stored energy effectively to sustain metabolic demands.

10. What is the role of acetyl-CoA in the Citric Acid Cycle?

A. It acts as a waste product

B. It serves as a substrate that combines with oxaloacetate

C. It regulates enzyme activity

D. It converts NADH to NAD+

Acetyl-CoA plays a critical role in the Citric Acid Cycle as it functions as a substrate that combines with oxaloacetate to initiate the cycle. When acetyl-CoA enters the cycle, it reacts with oxaloacetate, forming citrate. This step marks the transition from glycolysis and the conversion of pyruvate into a usable form of energy. The formation of citrate from acetyl-CoA and oxaloacetate is essential because it sets off a series of enzymatic reactions that lead to the production of energy-carrying molecules such as NADH, FADH2, and ATP. This central role of acetyl-CoA ensures that the cycle continues to process and extract energy from carbon-containing compounds. Understanding this function of acetyl-CoA is crucial for grasping how metabolic pathways are interconnected and how energy production takes place in cells.