What is Lipid Metabolism and Beta-Oxidation?

Worksheet

Beta-oxidation is the mitochondrial pathway that repeatedly removes 2-carbon acetyl-CoA units from a fatty acid chain, producing FADH2 and NADH each cycle until the whole fatty acid is converted into acetyl-CoA for the Krebs cycle.

Questions

1. What molecule is released each cycle of beta-oxidation?

A) Pyruvate
B) Acetyl-CoA
C) Glucose
D) Lactate

2. How many acetyl-CoA molecules does a 16-carbon fatty acid (palmitic acid) yield?

A) 6
B) 7
C) 8
D) 16

3. What carries fatty acyl-CoA across the mitochondrial membrane?

A) Hemoglobin
B) Carnitine
C) Albumin
D) Insulin

4. Which two electron carriers are produced during each beta-oxidation cycle?

A) NADH and FADH2
B) ATP and ADP
C) NADPH and FADH2
D) GTP and ATP

5. Palmitic acid has 16 carbons. How many beta-oxidation cycles and how many acetyl-CoA molecules does it yield?

6. Stearic acid has 18 carbons. How many acetyl-CoA molecules and beta-oxidation cycles does it produce?

7. Using P/O ratios (NADH = 2.5 ATP, FADH2 = 1.5 ATP, and 10 ATP per acetyl-CoA through the Krebs cycle/ETC), estimate the net ATP yield of complete oxidation of one palmitic acid (8 acetyl-CoA, 7 FADH2, 7 NADH from beta-oxidation).

8. Define: What is beta-oxidation?

9. Define: How many carbons does each beta-oxidation cycle remove?

10. Define: What shuttles fatty acids into the mitochondria?

Answer Key

1. B) Acetyl-CoA - Each cycle cleaves off a 2-carbon acetyl-CoA unit from the fatty acid chain.

2. C) 8 - Acetyl-CoA = n/2 = 16/2 = 8.

3. B) Carnitine - The carnitine shuttle transports fatty acyl groups into the mitochondrial matrix.

4. A) NADH and FADH2 - Each cycle generates 1 NADH and 1 FADH2 before releasing acetyl-CoA.

5. Cycles = (n/2) 1 = (16/2) 1 = 7 cycles Acetyl-CoA produced = n/2 = 16/2 = 8 Result: 7 cycles, producing 8 acetyl-CoA, 7 FADH2, and 7 NADH

6. Acetyl-CoA = n/2 = 18/2 = 9 Cycles = (n/2) 1 = 9 1 = 8 Result: 8 cycles, producing 9 acetyl-CoA

7. Acetyl-CoA via Krebs cycle: 8 10 = 80 ATP Beta-oxidation FADH2: 7 1.5 = 10.5 ATP Beta-oxidation NADH: 7 2.5 = 17.5 ATP Total = 80 + 10.5 + 17.5 = 108 ATP Minus activation cost (2 ATP-equivalents) = 106 ATP Result: about 106 net ATP per palmitic acid

8. The mitochondrial breakdown of fatty acids into 2-carbon acetyl-CoA units, generating FADH2 and NADH each cycle.

9. Two carbons, released as one acetyl-CoA molecule.

10. Carnitine, via the carnitine shuttle system.