

UMCH EMEM EPHRAIM

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MLS

BCH204: Beta oxidation of fatty acids.

Assignment:

Describe the three stages of Beta Oxidation.

Beta oxidation is the pathway for metabolism of fatty acids. It begins from Beta carbon, third carbon. It takes place in the mitochondria.

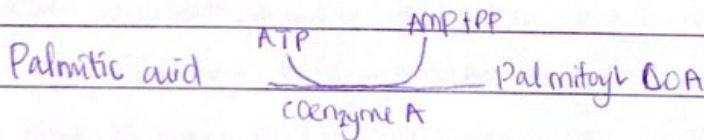
Three stages of Beta oxidation

- 1) Activation of fatty acids.
- 2) Transport of fatty acyl CoA into mitochondria
- 3) Beta oxidation.

Activation of fatty acids:

Long chain fatty acids: They are activated by ATP and co-enzyme A (Acyl-CoA Synthase) to form fatty acyl-CoA. While short chain fatty acids are activated in mitochondria.

Eg

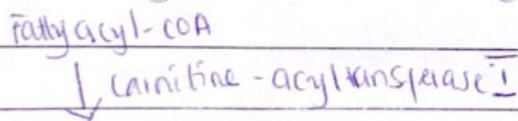


ATP is converted to AMP and pyrophosphate (PP) which is cleaved by pyrophosphatase to two inorganic phosphate (2Pi). Therefore two high energy phosphate bonds are cleaved. So the equivalent of two molecules of ATP is used for fatty acid activation.

Transport of fatty acyl CoA into mitochondria.

Fatty acyl-CoA from the outer membrane react with acine in the outer mitochondrial membrane forming "fatty acylcarnitine" the enzyme used is carnitine acyltransferase I (AT1).

~~(AT1)~~ Fatty acylcarnitine passes to the inner membrane where it reforms to fatty acyl-CoA which enters the matrix. The enzyme used is carnitine acyltransferase I (AT1).



Fatty acyl carnitine

↓ [carnitine acyltransferase II]

Fatty acyl-CoA in matrix of mitochondrion.

Also known as the carnitine shuttle system.

Beta oxidation of fatty acids.

Beta oxidation or Degradation consists of four sequential stages. Therefore, these stages are repeated until all carbons of fatty ~~acid~~ acyl-CoA are converted to acetyl CoA.

For even-chain fatty acids

1) FAD accepts hydrogens from a fatty acyl-CoA in the first step. A double bond is produced between the α & β carbons to form an enoyl-CoA.

FADH₂ produced interacts with electron transport chain generating ATP

Enzyme used: Acyl-CoA dehydrogenase.

2) β -hydroxyacyl-CoA is oxidized by NAD⁺ to β -ketoacyl-CoA. NADH produced interacts with electron transport chain to generate ATP.

Enzymes used: L-3-hydroxyacyl-CoA dehydrogenase.

For odd chain fatty acids:

Beta oxidation of odd-chain fatty acids produce acetyl CoA & Propionyl-CoA.

As these fatty acids repeat the four steps of Beta oxidation producing acetyl CoA until the last cleavage when the three remaining carbons are released as propionyl-CoA which can be converted to glucose.

For unsaturated fatty acids:

Beta oxidation of unsaturated fatty acids require enzymes in addition to the four that catalyze the repetitive steps of Beta-oxidation. The reaction path may differ depending on whether the double bond is at an even or odd-numbered carbon position.

So, the Beta-oxidation occurs until a double bond of the unsaturated-fatty acids is near the carboxyl end of fatty acyl chain.

Overall reaction of Beta-oxidation: C_n -acyl CoA + FAD + NAD⁺ + H₂O + CoA → C_{n-2} acyl CoA + FADH₂ + NADH + H⁺ + acetyl CoA.