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Question:

Describe the three (3) stages of Beta Oxidation.

Answer:

Beta oxidation is the pathway for catabolism of fatty acids. It begins from beta-carbon, second carbon and takes place in the mitochondria.

The three stages of Beta Oxidation are:

1. Activation of fatty acids
2. Transport of fatty acids
3. Beta Oxidation

1. Activation of fatty acids.

Long chain fatty acids: They are activated by ATP and Co-synthesise a CoA-Synthetase to form fatty acyl-CoA while,

Short chain fatty acids are activated in mitochondria.
by Palmitic acid $\xrightarrow[\text{Co-enzyme A}]{\text{ATP} \rightarrow \text{AMP}}$ Palmitoyl CoA

ATP is converted to AMP and pyrophosphate (PP) which is cleaved by pyrophosphatase to two inorganic phosphate (2Pi) therefore 2 high energy phosphate bonds are cleaved. So the equivalent of two molecules of ATP is used for fatty acid activation. Activation of fatty acid takes place on the outer membrane of mitochondria.

2. Transport of fatty acyl-CoA into mitochondria (Carnitine)
Fatty acyl-CoA from the outer membrane react with Carnitine in the outer mitochondrial membrane forming fatty acylcarnitine.

Fatty acid molecules pass to the liver molecules where they
referred to fatty acyl-CoA which enters the mitochondria. The
enzyme used is carnitine acyltransferase II (CAT II).

Fatty acyl-CoA

↓
carnitine acyltransferase I

↓
fatty acyl carnitine

↓
carnitine acyltransferase II

Fatty acyl-CoA in matrix of mitochondria

also known as the carnitine shuttle system.

3. Beta Oxidation of Fatty acids.

Beta Oxidation or Degradation consists of four sequential steps.

Moreover, these steps are repeated until all carbon of fatty
acyl-CoA are converted to acetyl CoA.

For even chain fatty acids -

i. FAD accepts hydrogen from a fatty acyl-CoA in the first
step. A double bond is produced between 2 and 3-carbon
to form an enoyl CoA.

FADH₂ produced in reaction with electron transport chain
generating ATP.

ii. β -hydroxyacyl-CoA is oxidized by NAD⁺ to β -ketoacyl-CoA.

For Odd chain fatty acids.

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